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TO ADVERTISERS

CHANGES for advertisements should be in this office by Friday noon for the following week's issue.

NEW ADVERTISEMENTS should be in the office not later than Monday noon to assure publication in that week's issue.

FAN MOTORS A GOOD INVESTMENT.

The fan motor has ceased to be a luxury and must now be considered a necessary and valuable piece of office furniture. The motors themselves have reached a high state of perfection, and are pretty well standardized. The cost is but moderate, and there are few investments which will make better returns throughout the hot season than a fan motor.

NEW AND YET OLD.

We hear, on every side, the reiteration that this is a day of absolute advance and of marked elimination of old-fashioned methods. But what of the twentieth century steam locomotive which uses a kerosene oil headlight, or the electric locomotive, so modern in everything yet using the enlarged cow-bell, manipulated with a string.

PLANS FOR AN ENGINEERING BUILDING.

From time to time we have discussed the desirability of some united action by the national engineering societies, for the purpose of securing adequate headquarters, and it is therefore with much pleasure that we announce, on another page of this issue, the generous offer of Mr. Andrew Carnegie, to give $1,000,000 for the erection of a suitable building, provided the societies secure the necessary ground.

Advantages of an Engineering Building.

The advantages of such a building have been discussed at length, and need only be touched upon here. The most important of these would undoubtedly be the educational and broadening effect upon the members of the various societies themselves. We boast to-day that we have the best-trained profession; but it can not be denied that there has been an increasing tendency toward specialization, and a consequent narrowness. It would seem that the joint ownership of an engineering building, in which individual engineers would meet members of other engineering professions, would give each a broader view of the aims of his brother engineers than could be gained in any other way. Moreover, the erection of a dignified building could not fail to have a beneficial effect on the public in bringing to its notice the strength of the engineering professions, and calling attention to their work.

The Responsibility for Success.

It remains now for the various engineering societies to exert themselves to the utmost, so as to make the best use of Mr. Carnegie's liberality. That this will be done we do not doubt for a moment, and we further believe that there are few ways in which Mr. Carnegie could have done more for the general welfare.

INSULATING MATERIALS WANTED.

There is no denying that highly specialized work has produced great advances along particular lines, and this is true not only of science in general, but of each department of science and application. On the other hand, the mind of the specialist is so taken up with his one subject that he has no time to broaden, and he is therefore deprived of much assistance which allied workers might render him. The specialist usually avoids the middle ground between two closely connected sciences, and sticks more closely to one topic.

Unbalanced Development.

This one-sided development often results in advancing one part of an art more rapidly than another, and finally the whole art may be held up by lack of some material or device, the development of which seemed to lie outside the line of specialists in the art in question.

Insulating Materials.

A serious instance of this was brought out by a paper presented by Dr. Max von Recklinghausen at the recent meeting of the American Electrochemical Society. Dr. von Recklinghausen discussed the various classes of insulation which are now used in electrical work, bringing out the advantages and disadvantages of each. He then pointed to the large field for research which here lies open to the chemist, successful work in which would reward the inventor handsomely.

A Lack of Suitable Insulating Materials.

The electrical arts are badly in need of cheaper insulating materials. We have now mica, rubber, various varnishes and shellacs, cotton and silk, and, for line work, glass and porcelain. Of these materials, glass and cotton are the only inexpensive ones, and the latter generally requires, in addition, a treatment with

some material, while to make the former reliable is troublesome and costly.

Materials Available.

In the paper mentioned, a number of materials were suggested, a proper study of which might give valuable results, and it is to be hoped that chemists will profit by these suggestions and turn their attention to this line of work. They are already in debt to electrical science for many new processes, and the electrician is fully within his rights in asking for assistance now that he is in need.

DEVELOPMENTS DUE TO ELECTRICITY.

In looking over the developments brought about by the use of electricity, one is apt to be so impressed with the showing made by the application for light and power that he is apt to overlook the other industries where electricity has played an important, although less apparent, part.

Electric Lighting and the Glass Industry.

Statistics are not lacking to show the spread of electric lighting, both arc and incandescent, but it would be interesting to trace the effect of these two industries upon the glass industry. Every incandescent lamp must have a bulb of glass, and all arc lamps require a large glass shade, while many of them have in addition an inner globe as well. Then, there is the important industry of carbon making, which did not exist before the invention of the arc light.

Manufacture of Insulators an Important Industry.

Another important business is the manufacture of insulators, both of glass and porcelain. Thousands of these are required in every installation, and for the largest work each weighs many pounds and consists of two or more complicated sections. Before the commercial application of the dynamo, the only insulators used were small glass caps placed on wooden pins.

Engine Development Owes Much to Electricity.

Steam engine building owes not a little to the demands made for prime movers suitable to drive dynamos, and the use of the steam turbine to any extent would be practically impossible were it not for the electric generator.

Electrochemical Developments.

In electrochemistry and electrometallurgy work has only been begun, and as these applications expand, other dependent industries will grow with them. The developments at Niagara are a case in point here. When the plant was first laid out it was thought that the power generated there would be used in factory operation, while, on the other hand, it is mostly used in electrochemical work, and other water powers have taken increased value because of the possibility of utilizing them in these or other electrical applications.

Other Industries Indebted to Electricity.

Our transportation systems are being revised, and with them have developed the making of copper and iron wires, insulating materials and rails. Large office buildings have been made possible by this invaluable aid. The demands of the dynamo builders have had a stimulating effect on the iron industry and have brought about the manufacture of special kinds of iron and steel. These are but a few of the other industries called into existence or benefited by electrical development.

More Work Ahead.

But though much has been done, much yet remains to be done. In factory work electricity is used as yet only as a motive power and for supplying light. There can be no doubt that there are many processes which can be and will be better carried out by electricity than is being done to-day. Its electrochemical action has been applied so far only in refining metals and in producing chemical compounds. This property of bringing about chemical action will doubtless be made use of in many other directions. That this has not been done to a greater extent already is doubtless due to the fact that the electrical engineers do not know the needs of the various industries, while those who are engaged in them are not aware of the possibilities which this agent offers them. The tendency of to-day seems to be to specialize; but there should be a better understanding of the values of electricity if we are to make the most of this—man's newest and best—servant.

DEPRECIATION AS A FACTOR IN THE ELECTRICAL FIRE HAZARD.

The importance of the subject naturally calls attention to any statements bearing upon the depreciation of electrical installations, particularly when the remarks are made by one of the technical attachés of the fire underwriters' organizations.

Depreciation Not to Be Ignored.

Depreciation is a subject not to be ignored in any department of commercial affairs; a neglect to provide against the insidious impairment of values from wear and tear, and the greater destruction by subsequent invention have ruined more manufacturers than inadequate mechanical knowledge or losses by dishonesty.

Depreciation Determined by Experience Only.

The impairment of electrical plant in such a manner as to increase its initial fire hazard is a subject which must be proved by experience and is not to be established by mere allegations.

Purpose of Rules Is to Reduce Fire Tax.

The insurance electrical rules, from humble beginnings, initiated new methods in underwriting the fire hazard, which has been followed by other means for the honorable purpose of reducing the enormous fire tax.

Special Fire Apparatus and Construction Encouraged.

The installation of special fire apparatus in large buildings, especially those devoted to large manufacturing industries, has been encouraged, more substantial methods of construction of buildings have been advocated, information in text, drawings and, to a certain extent, specifications upon these subjects have been widely disseminated, all for the purpose of reducing the initial hazard, and establishing means for efficiently extinguishing, in their early stages, fires which fate decrees as inevitable.

Cost of Protection Met by Insurance Concessions.

The cost of this work to owners of properties has been enormous, and the trend of evidence warrants the belief that in the long run the decreased fire loss will justify these expenditures, which are met by concessions in the tariff on insurance policies, for a fire is an occurrence which

is an abstraction of assets and not, like other financial misfortunes, merely a transfer of property.

Old Policy Antagonistic to New Methods.

The old-time underwriter frowned upon these methods of protection, alleging that they were merely expedients to reduce premiums, and that numerous contingencies reduced the operative efficiency of such apparatus. Their policy was to "protect the hazard by the rate," let other people's affairs alone, estimate the hazard, bet on the chance, insure anything and charge accordingly.

No Premium on Ignorance.

There is no premium on ignorance, and the financial results are showing greater profits in the new methods.

Underwriters Not Alone Responsible for Improved Conditions.

But the underwriters have not done it all, and no one with the facts at hand could ever make such an assumption, for builders, architects, manufacturers of fire apparatus and, above all, owners of properties, have cooperated in whole and in detail in this work.

Electrical Interests Have Borne Much of the Burden.

The solution of problems of the commercial application of generator currents also revealed other problems as to methods of installation and use, and while the beginning and end of these problems have been closely identified with the underwriters to the extent to which they may have raised questions and promulgated the answers, yet the great middle ground of solution of difficulties has rested solely with the electrical interests which have given of their skill in devising means and methods; and have, moreover, inspired the various subsidiary industries to a cooperation which should obtain better apparatus with improved conditions of operation.

Expansion of Underwriters' Rules.

These underwriters' rules in the early days were as limited as the apparatus to which they applied. With the extension of electrical apparatus there was a corresponding breadth and length of these rules, until there is now a board of arbitration to pass upon their interpretation in disputed cases, veritably a constitution and a court, but no person has as yet defined their authority or stated the measure of their scope.

Underwriters' Rules of Great Value.

Beyond an increase of insurance rates in cases of infraction, their function appears to be strangely negative on the surface, yet they are of great value in reaching toward a standardization of methods, and their influence is a powerful concomitant in electrical industries.

Improved Apparatus Inspired More Rigid Requirements.

Improved apparatus has developed more exacting rules. Slate switchboards made by electric lighting companies, inspired rules asking for slate switchboards; tubular fuses begat rules to match; telephone companies made protectors and protectors were demanded; power plants were equipped with circuit-closers, and such devices became enruled. Study the evolution of these rules as one may, it will be seen that throughout the electric interests were the pioneers in means for the preservation of plant and the maintenance of continuous service.

Depreciation of Electrical Machinery Not the Result of Use.

Electrical plant is physically permanent in its nature, to the extent that it is not like other machinery subject to impairment by its normal use. The depreciation of aerial line plant is largely one of pole decay, such as nature imposes on the posts of a division fence, and not because the wires form part of circuits. Internal plant is exposed to various changes, chances and mishaps which apply to any equipment within a building, save in lessened degree, but its depreciation is not a matter of wear and tear resulting from electrical use, for the results would have been the same were the wires "dead."

Depreciation Due to Improved Apparatus Relative, Not Absolute.

There is a relative depreciation in the comparison of former with present methods which is not an impairment of the original but an appreciation of the subsequent, as is the case of every progress by enterprising men. Except as to accidental injuries, which are outside of electrical use, these old installations are as good as they ever were; if they were once safe, they are not now hazardous.

Older Plants Not to Be Condemned Because Newer Ones Are Better.

It is granted that new wiring methods are more sightly, that subsidiary apparatus better serves purposes of convenience, and that there is less "drop" in a well-proportioned system of wiring, but are these reasons why early installations should be wantonly condemned, because the electrical inventors have made improvements?

Outlay for Enlarged Service Has Been Enormous.

The necessary changes in central plants of all branches of electrical utilities—in lighting, transmission of power, street railways and telephones—to fill the increased public demand for electric service have required fabulous expenditures in augmenting the units and extending the distribution.

Profits and Losses Should Be Balanced.

The consideration of any subject of widespread public application must be drawn as on a balance sheet. Steam railroads carry people safer than highways, but there are accidents; more vessels float than founder; the rarity of boiler explosions makes fortunes beyond the dreams of avarice for the casualty insurance companies.

Like all forms of energy, electricity is a good servant and a bad master, and the rarity of unfortunate occurrences shows that it is arbitrarily restrained to its proper functions.

Safeguards Vouchsafed by Electricity.

Outside of its utilities in everyday service, of its ministrations as a luxury of a few years ago and a necessity of today—both in the same generation—consider its emergency functions. It is a fire-alarm in not merely the apparatus of city fire departments, the special manual and automatic fire-alarms, but every telephone is a fire-alarm which also awaits the reassuring answer that help is at hand; railroad trains are guarded by the electric signal plant which makes high speed possible; trolley lines are run by electric signal and by telephone; the police patrol of cities is supervised by electricity, and, in short, the congested intensity of modern life is absolutely dependent upon the safeguards vouchsafed by electricity.

Water Power in Electrical Supply.

By Alton D. Adams.

ELECTRICAL supply from transmitted water power is now distributed in more than fifty cities of North America. These include Mexico City, with a population of 402,000; Buffalo and San Francisco, with 352,387 and 342,782 respectively; Montreal, with 266,826, and Los Angeles, St. Paul, and Minneapolis, with populations that range between 100,000 and 200,000 each. North and south these cities extend from Quebec to Anderson, and from Seattle to Mexico City. East and west the chain of cities includes Portland, Springfield, Albany, Buffalo, Hamilton, St. Paul, Butte, Salt Lake City and San Francisco. To reach these cities the water power is electrically transmitted, in many cases dozens, in a number of cases scores, and in one case more than two hundred miles. In the East, Canada is the site of the longest transmission, that from Shawinigan Falls to Montreal, a distance of eighty-five miles.

From Spier Falls to Albany the electric line is forty miles in length. Hamilton is thirty-seven miles from that point on the Niagara escarpment where its electric power is developed. Between St. Paul and its electric water power station, on Apple River, the transmission line is twenty-five miles long. The falls of the Missouri River at Cañon Ferry are the source of the electrical energy distributed in Butte, sixty-five miles away. Los Angeles draws electrical energy from a plant eighty-three miles distant on the Santa Ana River. From Colgate power-house, on the Yuba, to San Francisco, by way of Mission San Jose, the transmission line has a length of 220 miles. Between Electra generating station in the Sierra Nevada Mountains and San Francisco is 154 miles by the electric line.

These transmissions involve large powers as well as long distances. The new plant on the Androscogin is designed to deliver 10,000 horse-power for electrical supply in Lewiston, Me. At Spiers Falls, on the Hudson, whence energy goes to Albany and other cities, the electric generators will have a capacity of 32,000 horse-power. From the two water power stations at Niagara Falls, with their twenty-one electric generators of 5,000 horse-power each, a total of 105,000, more than 16,000 horse-power is regularly transmitted to Buffalo alone; much the greater part of the capacity being devoted to local industries. Electrical supply in St. Paul is drawn from a water power plant of 4,000 and in Minneapolis from a like plant of 7,400-horse-power capacity. The Cañon Ferry station, on the Missouri, that supplies electrical energy in both Helena and Butte has a capacity of 10,000 horse-power. Both Seattle and Tacoma draw their electrical supply from the 8,000-horse-power plant at Snoqualmie Falls. The Colgate power-house, which develops energy for San Francisco and a number of smaller places, has electric generators of 15,000 horse-power aggregate capacity. At the Electra generating station, where energy is also transmitted to San Francisco and other cities on the way, the capacity is 13,330 horse-power. Electrical supply in Los Angeles is drawn from the generating station of 4,000 horse-power, on the Santa Ana River, and from two stations, on Mill Creek, with an aggregate of 4,600, making a total capacity of not less than 8,600 horse-power. Five water power stations, scattered within a radius of ten miles and with 4,200 horse-power total capacity, are the source of electrical supply in Mexico City.

The foregoing are simply a part of the more striking illustrations of that development by which falling water is generating hundreds of thousands of horse-power for electrical supply to millions of population. This application of great water powers to the industrial wants of distant cities is hardly more than a decade old. Ten years ago Shawinigan Falls was an almost unheard of point in the wilds of Canada. Spier Falls was merely a place of scenic interest; the Missouri at Cañon Ferry was not lighting a lamp or displacing a pound of coal; that falling water in the Sierra Nevada Mountains should light the streets and operate electric cars in San Francisco seemed impossible, and that diversion of Niagara, which is destined to develop more than a million horse-power and leave dry the precipices over which the waters now plunge, had not yet begun. In some few instances where water power was located in towns or cities, it has been applied to electrical supply since the early days of the industry. In the main, however, the supply of electrical energy from water power has been made possible only by long-distance transmission. The extending radius of electrical transmission for water powers has formed the greatest incentive to their development. This development in turn has reacted on the conditions that limit electrical supply and has materially extended the field of its application. Transmitted water power has reduced the rates for electric service. It may not be easy to prove this reduction by quoting figures for net rates, because these are not generally published, but there are other means of reaching the conclusion.

In the field of illumination electricity competes directly with gas, and in the field of motive power with coal. During the past decade it is well known that the price of gas has materially declined and the price of coal, barring the recent strike period, has certainly not increased. In spite of these reductions electrical supply from water power has displaced both gas and coal in many instances.

Moreover, the expansion of electric water power systems has been decidedly greater, as a rule, than that of electrical supply from steam-driven stations. An example of the fact last stated may be seen in Portland, Me. In the spring of 1899, a company was formed to transmit and distribute electrical energy in that city from a water power about thirteen miles distant. For some years, prior to and since the date just named, an extension electric system with steam power equipment has existed in Portland. In spite of this, the system using water power, on January 1, 1903, had a connected load of 352 enclosed arcs and 20,000 incandescent lamps, besides 835 horse-power in motors. It is probably safe to say that these figures represent fully one-half the electric load of the city.

Comparing the expansion of electric water power systems with those operated by steam, when located in different cities, Hartford and Springfield may be taken on the one hand and Fall River and New Bedford on the other. The use of water power in electrical supply at Hartford began in November, 1891, and has since continued to an increasing extent. Throughout the same period electrical supply in Fall River has been derived exclusively from steam. In 1890 the population of Hartford was 53,230, and in 1900 it stood at 79,850, an increase of fifty per cent. At the beginning of the decade Fall River had a population of 74,398, and at its close the figures were 104,863, a rise of 40.9 per cent. In 1892 the connected load of the electric supply system at Fall River included 451 arc and 7,800 incandescent lamps, and

motors aggregating 140 horse-power. By 1901 this load had increased to 1,111 arcs, 24,254 incandescent lamps, and 600 horse-power in motors. The electric supply system at Hartford in 1892 was serving 800 arcs, 2,000 incandescent lamps, and no motors. After the use of transmitted water power during nine years the connected load of the Hartford system had come to include 1,679 arcs, 68,725 incandescent lamps and 3,476 horse-power of motor capacity in 1901. At the beginning of the decade Hartford was far behind Fall River in both incandescent lamps and motors, but at the end Hartford had nearly three times as many incandescent lamps and nearly six times as great a capacity in connected motors. As Fall River had a population in 1900 that was greater by thirty-one per cent than the population of Hartford, and the percentage of increase during the decade was only 9.1 lower in the former city, water power seems to have been the most potent factor in the rise of electric loads in the latter. Electric gains at Hartford could not have been due to the absence of competition by gas, for the price of gas there in 1901 was $1 per 1,000 cubic feet, while the price in Fall River was $1.10 for an equal amount.

Water power began to be used in electrical supply at Springfield during the latter half of 1897. In that year the connected load of the Springfield electric system included 1,006 arcs, 24,778 incandescent lamps, and motors with a capacity of 647 horse-power. Five years later, in 1902, this connected load had risen to 1,399 arc lamps, 45,735 incandescent lamps, and a capacity of 1,025 horse-power in electric motors. At New Bedford, in 1897, the electric system was supplying 406 arc and 22,122 incandescent lamps besides motors rated at 298 horse-power. This load, in 1902, had changed to 488 arcs, 18,055 incandescent lamps, and 432 horse-power in capacity of electric motors. From the foregoing figures it appears that while eighty-two arc lamps were added in New Bedford, 393 such lamps were added in Springfield. While the electric load at New Bedford was increased by 134 horse-power of motors, the like increase at Springfield was 378 horse-power, and while the former city lost 4,067 from its load of incandescent lamps, the latter gained 20,957 of these lamps. During all these changes electrical supply in Springfield has come mostly from water power, and that in New Bedford has been the product of steam. Population at Springfield numbered 44,179 in 1890, and 62,059 in 1900, an increase of 40.5 per cent. In the earlier of these years New Bedford had a population of 40,733, and in the later 62,442, an increase of 53.3 per cent. In 1902 the average price obtained for gas at Springfield was $1.04 and at New Bedford $1.18 per 1,000 cubic feet.

Springfield contains a prosperous gas system, and the gross income there from the sale of gas was thirty-one per cent greater in 1902 than in 1897. During this same period of five years the gross income from sales of electrical energy, developed in large part by water power, increased forty-seven per cent. For the five years of general depression, ending in 1897, the gross annual income of gas sales in Springfield rose only five per cent and the like electric income nine per cent. In the five years last named the electrical supply system was operated with coal.

The application of transmitted water power in electrical supply has displaced steam as a motive power in many large industrial plants that never would have been operated from steam-driven electric stations. An example of this sort exists at Portland, where one of the motors operated by the electric water power system, in an industrial plant, has a capacity of 300 horse-power. Every pound of coal burned in Concord, N. H., is hauled by the single steam railway system entering that city, which railway operates large car and repair shops there. Some years ago the railway installed a complete plant of engines, dynamos and motors for electric driving throughout these shops. These engines and dynamos now stand idle and the motor equipment, with an aggregate capacity of 590 horse-power, is operated with energy purchased from the local electrical supply system and drawn from water power.

Another striking example of the ability of electric water power systems to make power rates that are attractive to large manufacturers may be seen at Manchester, N. H. One of the largest manufacturing plants in that city purchases energy for the operation of the equivalent of more than 7,000 incandescent lamps, and of motors rated at 976 horse-power, from the electrical supply system there, whose generating stations are driven mainly by water power. The Manchester electrical supply system also furnishes energy, through a substation of 800-horse-power capacity, to operate an electric railway connecting Manchester and Concord. This electric line is owned and operated in common with the only steam railway system of New Hampshire, so that the only inducement to purchase energy from the water power system seems to be one of price.

In Buffalo the electric transmission system from Niagara Falls supplies about 4,000 horse-power to comparatively large motors in manufacturing and industrial works, and 7,000 horse-power to the street railway system, besides another 4,000 horse-power for general service in lighting and small motors. Few large cities in the United States have cheaper coal than Buffalo, and in Portland, Concord and Manchester coal prices are moderate. In the Rocky Mountain region, where coal is more expensive, the greater part of the loads of some electric water power systems is made up of large industrial works. In Salt Lake City the electrical supply system, which draws its energy almost exclusively from water powers, had a connected load of motors aggregating 2,600 horse-power as far back as 1901, and also furnished energy to operate the local electric railway, and several smelters six miles south of the city, besides all the local lighting service. As good lump coal sells in Salt Lake for $4.50 per ton, slack at less than one-half this figure, and the population there by the late census was only 53,531, the figures for the load of motors are especially notable. At Helena energy from the 10,000-horse-power station at Cañon Ferry operates the local lighting and power systems, two smelting and a mining plant.

In Butte, energy from the station just named operates the works of five smelting and mining companies, driving motors that range from 1 to 800 horse-power in individual capacity. The capacity of the Butte substation is 7,600 horse-power.

The great electric water power system marked by the Santa Ana station at one end and the city of Los Angeles at the other, eighty-three miles distant, includes more than 160 miles of transmission lines, several hundred miles of distribution circuits, and supplies light and power in twelve cities and towns. Among the customers of this system are an electric railway, a number of irrigation plants, and a cement works. These works contain motors that range from 10 to 200 horse-power each in capacity. Motors of fifty horse-power or less are used at pumping stations in the irrigation systems.

Applications of water power in electrical supply during the past decade have prepared the way for a much greater movement in this direction. Work is now under way for the electric transmission of water power, either for the first time or in larger amounts, to Albany,

Toronto, Chicago, Duluth, Portland, Oregon, San Francisco, Los Angeles, and dozens of other cities that might be named.

Another ten years will see the greater part of electrical supply on the American continent drawn from water power.

CITIES WITH ELECTRICAL SUPPLY FROM WATER POWER.

City.	Miles From Water Power to City.	Horse-Power of Water-Driven Stations.	Population.
Mexico City	10 to 15	4,200	402,000
Buffalo	23	*16,000	352,387
Montreal	85	....	266 826
San Francisco	222 / 154	15,000 / 13,330	342,782
Minneapolis	10	7,400	202,718
St. Paul	25	4,000	163,065
Los Angeles	83	8,600	102 479
Albany	40	32,000	94,151
Portland, Ore	....	....	90 426
Hartford	11	3,600	79,850
Springfield, Mass.	6	3,780	62,059
Manchester, N. H.	13.5	5,370	59,987
Salt Lake City	36.5	10,400	53,531
Portland, Me.	13	2,660	50,145
Seattle	....	8,000	80,671
Butte	65	10,000	30,470
Oakland	142	....	66,900
Lewiston, Me.	3	10,000	23,761
Concord, N. H.	4	1,000	19,632
Helena, Mont.	20	....	10,770
Hamilton, Ont.	35	8,000	....
Quebec	7	3,000	....
Dales, Ore.	27	1,330	....

*Power received.

Only the largest city supplied from each water power is named above. Thus the same transmission system enters Albany, Troy, Schenectady, Saratoga and a number of smaller places.

In the April issue of the *Journal of Electricity, Power and Gas*, is given a brief account of an accident to the Ogden-Salt Lake transmission line. On the morning of June 27, a severe short-circuit occurred, lasting but a short time, and about an hour later a large crane was found under the line, dead but not burned. A voltmeter chart is reproduced which shows the effect of the accident upon the line. There was a sudden fall of potential almost to zero, followed by a rise much above normal, after which the voltage returned to normal. A photograph of the dead crane shows no noticeable damage, although the Fresno eagles and the Sacramento stork were "vaporized entirely."

The next international congress of applied chemistry is to be held at Berlin, and will commence on the second of June, lasting about a week. The congress has been held successively at Brussels, Paris, Vienna and a second time at Paris, and there is no doubt that the Berlin meeting will be as interesting as its predecessors. The congress will be opened and also closed by a general meeting, while the rest of the time will be devoted to the work of the sections. The programme includes an excursion in the suburbs of Berlin, at Waunsee, and the congress will close on June 8.

INSULATING MATERIALS—A FIELD FOR THE CHEMIST.[1]

BY DR. MAX VON RECKLINGHAUSEN.

The great hopes we had at the beginning of the last decade as to the future of the electrochemical industry in its purest form, that is, as technical electrolysis, were not all realized. The main advance during this time in the, I may say, electrical manufacture of chemical and similar products has been due not to the use of current as electrolyzer, but to the application of the electric current as source of heat for chemical and physical reactions, which heretofore, if known at all, were only feasible on a laboratory scale.

The manufacturing chemist is the one who has gained enormously during this time, because the electrical engineer has put at his disposal heat sources of an undreamed of magnitude.

The advance in electrical engineering has enabled the technical chemist to use economically high temperature reactions for making products and compounds which until then were scarcely obtainable in the laboratory.

The electrochemist is therefore under the greatest obligations to the electrical industry. It is only fair that he should show his gratitude by helping the electrical engineer out of his troubles in a field where his chemical research is of vital importance. I mean the field of the electrical insulating materials.

Up to now, the electrical engineer, in most cases, has been left to himself to find the best insulating material for his particular purpose. All he could do was to pick out the most promising ones among those offered to him by the trade. But he is far from having the ideal materials for the different types of insulation, especially for high-tension work, which is greatly handicapped by the lack of suitable insulating materials.

This is therefore the time when the chemist should step in and use his knowledge and ability for producing for the electrical engineer insulating materials that are better and more satisfactory than those obtainable to-day.

While there are doubtless many chemists, especially among the makers of varnishes and oils, and so on, who are on the outlook in this important field of the electrical insulating materials, one must say that among chemists generally there is but little interest in these matters and generally small appreciation of the enormous value that chemical work in this field would have for the advance of the electrical industry.

One can safely say that one of the main reasons why the electrical engineer got little help in this field from the chemist, lies in the fact that the chemist does not appreciate the different wants of the electrical engineer. It happens over and again that chemists offer materials for insulation which may have one good property, may have enormous resistance to passage of current, but be so highly inflammable or so low melting as to be utterly useless for the purpose intended.

In the following I shall try to give a general idea of the desirable and the undesirable qualities of the prominent insulating materials used now-a-days, and shall furthermore try to point out where chemical research would be particularly important.

To start with, we have to classify the properties under which the different insulating materials have to be considered.

1. Electrical Properties—(*a*) Insulation resistance or conductivity, expressed in ohms per cubic centimetres. (*b*) Disruptive or dielectric strength, measured by the high-potential voltage necessary to puncture the material. (*c*) Dielectric constant or specific inductive capacity measured by the capacity in microfarads of a condenser having the particular material as dielectric separating the metal plates. (This property is less important than the ones mentioned under *a* and *b*.)

2. Mechanical Properties—(*a*) Workability and strength, for solids. (*b*) Workability and flexibility, for semi-solids. (*c*) Viscosity for liquids.

3. Chemical Properties—(*a*) Combustibility. (*b*) Property of resisting influence of moisture (hygroscopic quality), air, oil, acids, etc.

The factors which may considerably influence the properties of the insulating materials during use are the following:

1. Rise of Temperature (going as far as melting or charring organic materials), due to: (*a*) Current passing in virtue of the insulation resistance, with not enough chance to radiate the heat generated. (*b*) Heat conducted into the insulating material from outside sources, such as the metallic conductor. (*c*) Dielectric hysteresis, due to very frequent application and withdrawal of high electrical stress, such as high-voltage alternating currents, with not enough chance to radiate heat generated.

2. Mechanical stress, resulting in change of shape or breaking.

[1] Paper read at the meeting of the American Electrochemical Society held at Chemists' Club, New York city, April 16-18.

3. Chemical action of water, oil, ozone, nitrous fumes (which may be generated by brush discharges near-by), gases and fumes developed by factory processess in the neighborhood of the electrical apparatus.

Desirable qualities are mainly good insulation resistance, high disruptive strength, decent mechanical properties, especially workability.

Undesirable are mainly combustibility and changes in the electrical and mechanical properties with rise of temperature or with age, and of course high price.

To classify chemically the insulating materials, it is practical to consider them under the headings of:

1. Organic materials, liquid and solid.
2. Mixtures of organic and inorganic materials.
3. Inorganic materials.

1A. Liquid Organic Materials—This chapter comprises the materials used mainly for transformer insulating and cooling, for condensers and more recently for circuit-breakers.

Such liquid insulators are the different oils and other liquid organic compounds.

Most properties of the oils as used now are desirable. The worst feature inherent to them is their combustibility. Flash test and viscosity test (and influence of long continued use on the same) give good idea of the usefulness of an oil for the purposes mentioned above.

In case of circuit-breakers, as well as of transformers, where accidental high potential may have arced through the oil, the broken down oil insulation should soon be repaired and the oil should come back to its original insulating power. At the same time it would be good that such oil does not develop too much low flash products, which bring with them the danger of fire.

In circuit-breaker work, some oils will break the arc off very sharply with corresponding back effect on inductance in the line, others will be slower in their action and may thus be more useful for such purposes.

Naturally one has to study the effect of the oils on the different materials they come in contact with. Fatty acids seem to be undesirable in such respects, because they are apt to react with copper.

To do away with the worst feature of oils, their combustibility, one has proposed to use halogen carbon compounds, instead of hydrocarbon compounds. It is distinctly worth investigating whether the products resulting from such liquids when the discharge goes through would be of too bad an effect on the apparatus. For instance, tetra-chloride of carbon would probably break up in carbon and free chlorine, and the latter would very likely injure the metal.

1B. Organic Compounds Used in a Solid of More or Less Plastic State—Typical representatives of this long line are the different varnishes, lacquers, drying oils, rubber, compounds made from blood, glue, all the different cellulose materials, such as used for textile fabrics, wood and mixtures of the different materials belonging to this group. It will be rather hard work to make material advance in this field by further research, as the makers of these materials have been on the outlook for improvements for some time.

I mainly want to point out some of the disadvantages of the materials used now-a-days. Many of them lose their mechanical strength and their insulating power and dielectric strength by age and by short or long duration of high temperature and high electric stress. All of them are more or less inflammable. Here is probably the point where a thorough chemical research could find a field. The pure cellulose compounds are probably very good in every regard, especially because they seem to be less affected by heat and less inflammable than the other materials of this group, but up to now they are fairly difficult to get into the desired dense mechanical shape. Nitrocellulose and other celluloid compounds are ideal in this way, but of course are out of question on account of their combustibility. New artificial masses, such as viscose cellulose made out of cellulose solution in acids, metal salts, etc., and similar products, may very well be worth experimenting on because they are free from nitro-groups and, therefore, probably little affected by heat. Also glue and gelatine compounds, made insoluble by different methods, ought to be examined for their usefulness as insulators, and if necessary chemically modified so as to compete successfully in properties and price with materials used now.

One point is important for dynamo and especially transformer insulation, namely, the oil used should not have dissolving or other effect on the insulating material. Furthermore, the insulation should not be affected by moisture which often in large amounts covers cold apparatus brought into warm rooms.

Complaints are heard of attack of some varnishes on particularly thin wires. For such purposes it may be good to prevent direct touch of the varnish and the metal by an intermediate coating.

Attempts are being made lately to produce asphalt compounds which seem to have many excellent properties, still it will be fairly hard to find some materials electrically and mechanically desirable but unaffected by oil and water.

I scarcely need mention the old problem of finding a replacement of the expensive gutta-percha.

2. Mixtures of Organic and Inorganic Materials—Typical representatives of this group are mainly materials made of asbestos or mica with varnish, rubber or paper, or similar materials out of the group mentioned before.

The asbestos compounds, as a rule, lack high insulating power, also mechanical strength, the mica paper lacks great flexibility and homogeneity.

3. Inorganic Materials—The representative materials out of this group are slate, marble, asbestos, porcelain and glass. They are, of course, practically unaffected by heat, but lack entirely flexibility, and are furthermore fairly expensive to form into the desired shapes. Better in the latter regard, but not as good as insulators, are cementlike mixtures made out of water glass and asbestos, or similar minerals. Progress in this field may be expected in the line of the castable cements, although up to now they seem to be too hygroscopic.

That even the mineral insulators become conductors at high temperatures has been found out by people working on the Nernst lamp, where after finding a good conductor at high temperature for the glower part, one had great trouble to find a good insulator for high temperatures for the heater part.

The main objection to marble for switchboard work is the great expense. Anything to replace marble would be of greatest importance. It should, of course, not be hygroscopic at all.

Some time ago this was found to be important for high-tension line insulators. The makers were careful to make the insulators absolutely non-hygroscopic by choosing glass free from alkali. Still the beneficial effect of this is to a certain extent over-rated, as the heat developed by the leakage current is enough to remove the water which may condense on the insulator.

A tremendous step forward for the electrical engineer would be an insulating material of the flexibility of asbestos and the ideally high insulating and dielectric strength of mica.

I have tried to give you, in the limited space to my disposal, an idea of the work which could be done in this line, and I hope you agree with me when I say that it is a field of very great importance and it would further the electrical industry and therefore all those industries depending on it. I should be very glad, indeed, if I succeed in inducing my fellow chemists to consider more than heretofore the large and important field of electric insulating materials.

The New Headquarters of the Stock Exchange, New York City.

A Description of the Power Plant, Annunciator Service and Telephone System.

THE new headquarters of the New York Stock Exchange was formally opened on Wednesday, April 22, 1903. The architectural features of the structure are such as to have excited universal commendation both from a utilitarian and artistic point of view. Mr. George B. Post, famous as the successful designer of many fine office buildings, was entrusted with the project of satisfying the requirements of a most critical body of men, as set forth by an exacting and painstaking building committee, composed of R. H. Thomas, chairman, J. T. Atterbury, R. P. Doremus, Ernest Groesbeck, H. G. S. Noble and Rudolph Keppler. So well has this committee labored that the governing committee of the New York Stock Exchange has shown its appreciation by erecting a bronze tablet on the interior wall of the exchange, facing the Broad street entrance, bearing these names.

In line with the magnificent architectural achievement, the mechanical equipment is probably the most complete and extensive of any building of a like nature in the world.

The building has a frontage on Broad street of 137 feet 8½ inches; on New street of 152 feet 10 inches, and on Wall street of 14 feet 8 inches. The largest rectangle that could be drawn in this plot was about 110 feet along Broad and New streets, forming the eastern and western limits, respectively, with 144 feet between these two streets.

The board room occupies this rectangle,

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FIG. 1.—TWO OF THE ELEVATOR PUMPS TO THE RIGHT, AT THE LEFT A MOTOR OPERATING A VENTILATING BLOWER, STOCK EXCHANGE, NEW YORK CITY.

and this room is reached by broad stairways from the Broad street entrance, the corridors leading from the Wall street and New street entrances being on a level with the board room floor.

The power plant is several stories be-

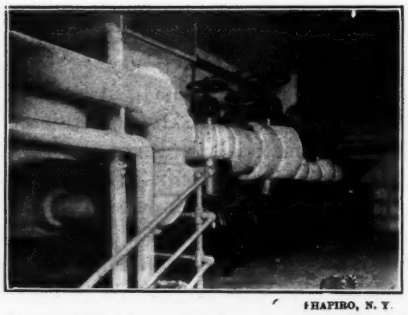

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FIG. 2.—THE STEAM HEADER AND CROSS-CONNECTIONS, POWER PLANT, STOCK EXCHANGE, NEW YORK CITY.

low the sidewalk, the floor being forty-two feet below the street level, thirty-three feet below the sewer main, and thirty feet below the water level.

This level is reached by means of both elevator and stairways situated in the southeast corner of the building. Probably the best idea of the layout of this remarkable installation is to assume a rectangle of the extreme dimensions noted above, with all of the available space utilized in a compact arrangement of the main and auxiliary apparatus, leaving each machine easily accessible for inspection or repair.

Beginning at the southeast corner of the rectangle, and proceeding along the western wall, are arranged, first, two storage air chambers, each nine feet in diameter and twelve feet high, built by Messrs. Fogarty Brothers, of New York city. These storage air chambers are used for the extensive pneumatic tube service, and are charged by a double steam air-compressor built by the Ingersoll-Sergeant Drill Company, of New York city, having a twelve-inch steam end and an eighteen and one-quarter inch air end. To the left of this air-compressor are two Continental water filters, and between these and the western wall are two Shone sewage ejectors. The sewage from the floors below the street level is carried through mains to this point, and then blown by air under twenty-five pounds pressure into the city sewage system. Four Westinghouse air pumps are used with these ejectors. Opposite the air-compressor, and separated from it by a wide passageway, is an auxiliary suction tank for the hydraulic elevators.

Proceeding along the eastern boundary, to the left of the water filters are two pumps, one for house service and one fire pump; to the east of these are two Westinghouse air pumps used in connection with the elevator system. Fig. 1 is a view looking down the centre of the rectangle. On the right and in the front of the picture are three Worthington elevator pumps, each fourteen inches by twenty inches and eleven inches by fifteen inches. Near-by is a safe lift pump, and behind these, but not shown in the illustration, is the elevator discharge tank. On the left of the photograph may be seen one of the motors operating one of the blowers. There are five of these blowers on this floor, two on a floor above, with an exhaust on the roof. The ventilating and heating system is one of the most complete in the world. The air chamber is situated on the left, as shown in Fig. 1, and every particle of air must pass through

an extensive cheese-cloth filter before it reaches the blowers. The system installed is capable of handling 26,000,000 cubic feet of fresh air per hour. The blowers are operated by C. & C. motors, rated at 220 volts, and for varying the speed each motor is controlled by a shunt rheostat, built by the Cutler-Hammer Manufacturing Company, of Milwaukee, Wis., and equipped with automatic underload and overload circuit-breakers. The motor driving the exhaust fan on the roof uses 137 amperes at a pressure of 220 volts. In the heating and ventilating system there was used about 270 tons of galvanized iron duct. Alfred R. Wolff was the consulting engineer, and the system was installed by Baker, Smith & Company, of New York city. There are also installed in this section two Blake boiler feed pumps.

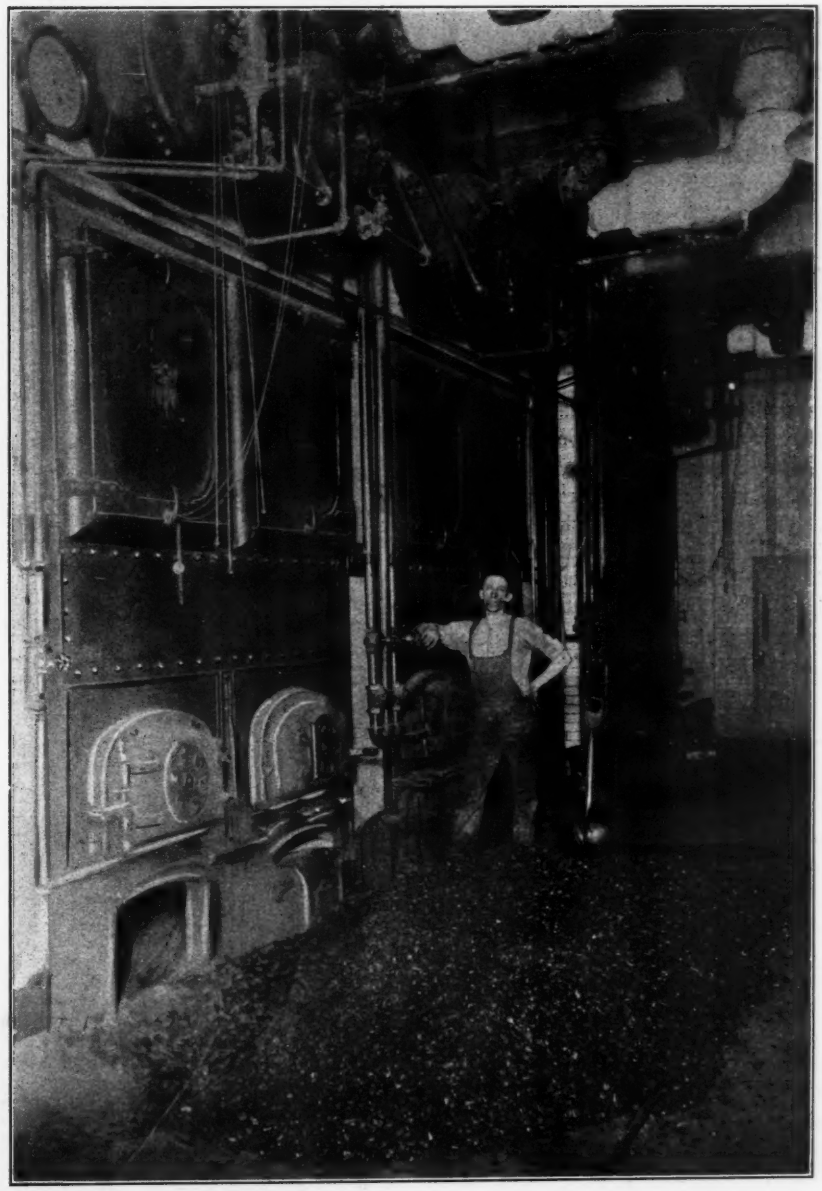
Referring again to Fig. 1, at the extreme end of the rectangle, at the western end of the building, are three 150-ton Carbondale refrigerating machines, and a brine tank with a capacity of 120 tons of chloride of calcium brine. To charge these machines it will take 70,000 pounds of aqua ammonia. These machines will be used to cool the air in summer and will also, throughout the year, be used to cool the provision chambers used in connection with the restaurant of the Luncheon Club. These machines will be operated by the exhaust steam, and to cool the air the brine will be pumped through a series of galvanized iron pipe coils having an aggregate length of seven miles.

At about the centre of the rectangle, to the right in Fig. 1, and well shown in Fig. 2, is a platform raised about six feet above the floor level. Upon this platform are mounted feed-water pumps, return pumps, feed-water filters, and two thermostat pumps. Upon this platform is also mounted the main steam header. This is sixteen inches in diameter and fifteen feet long. Exhaust steam is brought through one end, and live steam through a Keiley reducing valve at the other end. Four branches are taken off from this header, three supplying steam coils for warming the air for the fresh air fans, and one supplying all the radiators throughout the building.

Underneath this platform is a high-pressure drip-tank, the height of water being controlled by a Keiley pump governor, and a Blake pump returns the water to the boiler; a blow-off tank, with pumps for sending the water to the sewer; a plumber's waste-water tank which takes care of water from the floor drains, safe waste, tell-tale pipes and refrigerator waste.

A sump is also located under this platform which takes care of the drainage oozing from the caissons and other sources. This is handled by three pumps cross-connected with the plumber's waste-water tank and sump. A low-pressure drip-tank is located in the pit, the height of water being controlled by a Keiley pump governor, and returned to the water by a Blake pump. There are in all, thirty-nine pumps in the installation.

Across the platform, on a lower level, is the boiler room. This is equipped with four Babcock & Wilcox boilers. Three of these have eighty-four four-inch tubes, eighteen feet long, arranged in tiers twelve long and seven high; two thirty-six-inch drums, seven-sixteenths inch thick, twenty-one feet ten and three-eighths inches long. One larger boiler has 112 four-inch tubes, sixteen wide and seven high; two thirty-six-inch drums, seven-sixteenths inch thick, twenty-one feet two and eleven-sixteenths inches long. These are normally rated for 200 pounds pressure, but the present working pressure is 125 pounds. Fig. 3 shows the boiler room. The furnaces are hand-fired, using natural draft furnished by a steel stack 200 feet high of flattened oval section, ninety inches in the greatest, and fifty-four inches in the shortest dimensions. A single-track railway conveys the coal from a large bunker, and removes the ash



SHAPIRO, N. Y.

FIG. 3.—THE BOILER ROOM, POWER PLANT, STOCK EXCHANGE, NEW YORK CITY.

to a sidewalk lift. The four boilers give an aggregate heating surface of 8,200 square feet. There is also installed in the boiler room a 600-horse-power Berryman feed-water heater.

The engine room is located in the northwestern section of the building, on a level with the platform shown in Fig. 2. This is a handsome room, and the fittings are of an exceptionally high order of excellence. There are three General Electric direct-current generators, direct-coupled to Ball & Wood tandem-compound engines. Two of these generators operate at 235 volts no load, and 242 volts full load, 1,033 amperes, 175 revolutions per minute. The third generator operates at 235 volts no load, and 242 volts full load, 620 amperes, 225 revolutions per minute. Two of these units are shown in Fig. 4, and Fig. 5 shows the third generator and a partial view of the handsome board for the steam gauges and time clock. Fig. 6 shows the automatic oiling system, built by the Siegrist Lubricator Company. Two of the small pumps in this group handle the engine oil, and two handle the cylinder oil. All of the oil, after passing through the engines, is delivered to a White Star oil filter, and returned for use in the engines. To the left of this apparatus is shown the storage battery switchboard, and at the extreme left of the view the end-cell switch for cutting in the end cells of the storage battery equipment. There are 135 cells of the chloride accumulator type with a discharge capacity of 100 amperes for eight hours, built by the Electric Storage Battery Company, of Philadelphia, Pa. Of these, twenty-four are end cells, and these are automatically placed in circuit as the discharge of the storage battery may require. The cells are charged by a ten-kilowatt booster made by the Western Electric Company.

On the storage battery switchboard there is a Weston voltmeter made to read so that the number of end cells connected up is indicated. On the end-cell switch a series of twenty-four coils is arranged, so connected as to form an exaggerated slide wire bridge. As the resistance in these coils is varied, the Weston voltmeter just mentioned indicates on the reading scale the number of the end cell in circuit. On the right-hand side of the board another bridge arrangement, used in connection with a Weston direct-reading voltmeter, indicates the voltage of any individual end cell. On this switchboard there is also placed a differential Thomson recording wattmeter. This shows the watts, both on charge and discharge. A Weston station voltmeter is used in connection with a voltmeter switch for determining the voltage on the main bus, the battery voltage, the bus and booster voltage, and for indicating both positive and negative grounds. Two "I. T. E." circuit-breakers are mounted on this board, and two pressure regulators, an end-cell regulating switch, and the main switches for charge and discharge, together with a station ammeter.

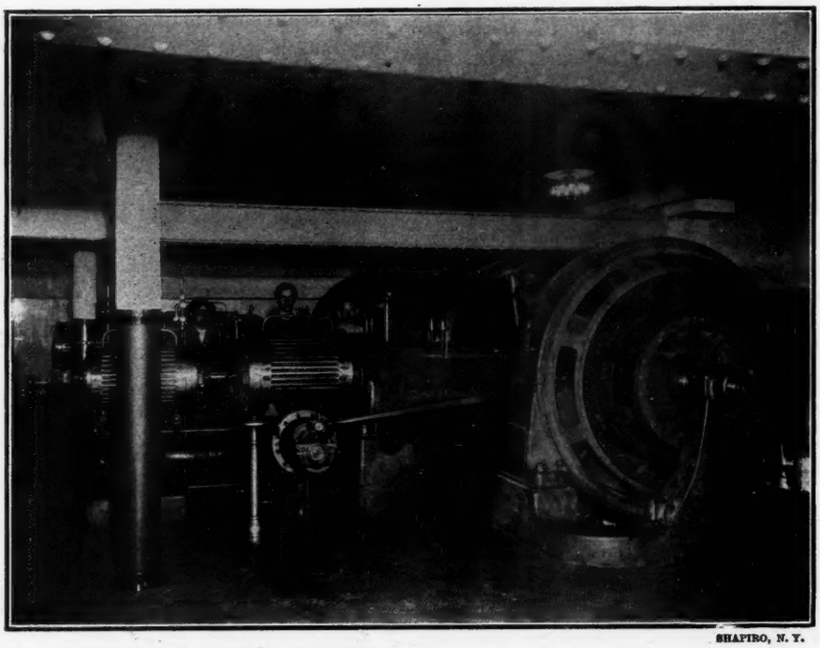


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FIG. 4.—PART OF THE ENGINE ROOM—THE 150-KILOWATT, DIRECT-CURRENT GENERATOR IN FOREGROUND, STOCK EXCHANGE, NEW YORK CITY.

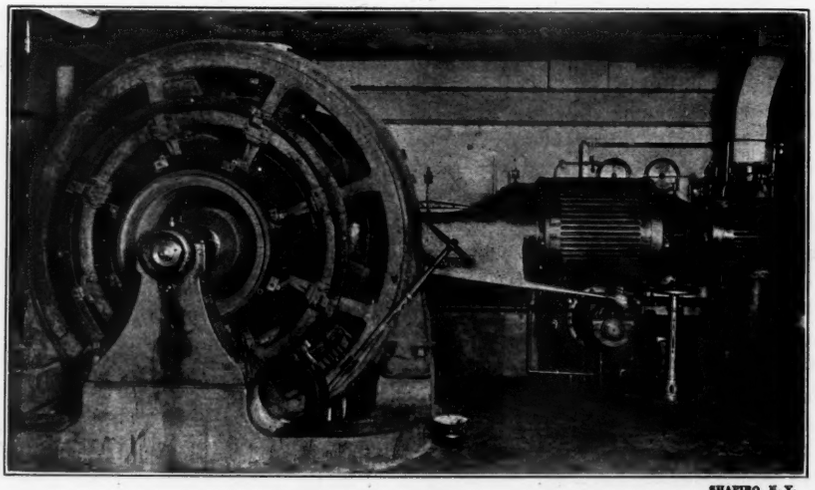

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FIG. 5.—THE 247-KILOWATT, DIRECT-CURRENT GENERATOR, AND PART OF THE STEAM GAUGE BOARD, ENGINE ROOM, STOCK EXCHANGE, NEW YORK CITY.

Fig. 7 shows the main switchboard. This is made up in three sections, each section being divided into two panels. The section on the extreme right of Fig. 7 is the lighting panels; upon the centre panels is mounted the controlling apparatus for the power distribution, and upon the panels at the extreme right are mounted the controlling switches and regulators for the generators. In the middle panels are two Thomson recording wattmeters, one for power and one for light, with the switches for the motors in the different parts of the building, operating the blowers and exhaust fans, and other auxiliary apparatus. On the generator panel are mounted three Weston ammeters, one differential voltmeter, and one Weston voltmeter, together with the main switches and the circuit-breakers. In one corner of the room there is a smaller switchboard upon which are mounted switches for controlling the signals and elevator lights, the watchman's

clock, and the house telephone service. On this switchboard is a Weston ammeter, reading to ten amperes, and a Weston voltmeter reading to twenty-five volts. The four starting boxes for five small motor-generators used for the elevator signals and house telephone service are also mounted on this board. Messrs. Pattison Brothers, of New York city, were the consulting electrical engineers, and the Charles Eidlitz Company, the electrical contractors.

The plant supplies power for 6,000 sixteen-candle-power, 235-volt incandescent lamps, seventy-five arc lamps, and about thirty motors, together with the current required for signals and house annunciators and telephones.

The engine room is finished in white enameled brick, with a mosaic tile flooring. Each engine is supplied by a single steam pipe which comes from the floor below, and each steam pipe is encased in polished sheet iron to a height of about five feet, and at this point is finished off with a polished brass collar. The steam supply pipes make a graceful curve to the engine, and this is the only part of the steam supply which is visible in the engine room.

One of the spectacular features of the exchange is the large annunciators in the board room. One of these annunciators is on the north wall of the room, the other being directly opposite on the south wall. These annunciators are each twenty-eight feet long by twenty-eight feet high, and are divided into thirteen sections, so that it is easy to become familiar with the location of individual numbers. Each number is nine inches square, and there are thirty-five numbers in each row. The lower tier of the numbers is twenty feet from the floor. Fig. 9 shows the annunciator on the south wall of the board room, and also the operator's station on a platform underneath the annunciator, where is located the master keyboard controlling the numbers on each annunciator.

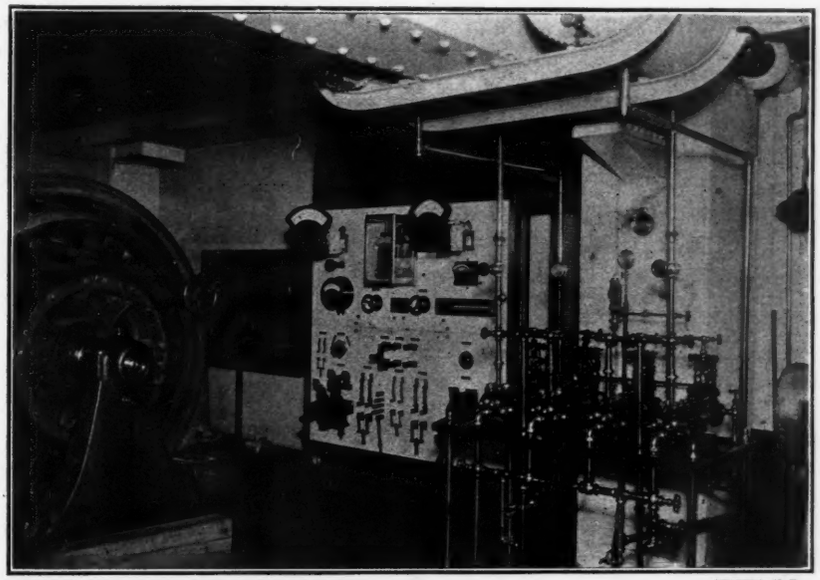

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FIG. 6.—THE AUTOMATIC OILING SYSTEM, SWITCHBOARD CONTROLLING STORAGE BATTERIES, AND END-CELL SWITCH, STOCK EXCHANGE, NEW YORK CITY.

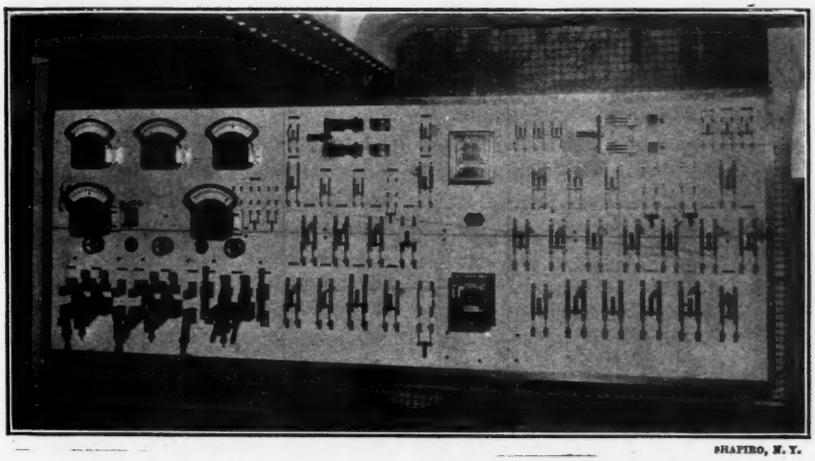

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FIG. 7.—THE MAIN SWITCHBOARD, STOCK EXCHANGE, NEW YORK CITY.

Each member of the exchange has a certain number, and on the master keyboard there are two buttons corresponding to each number. Each annunciator has a capacity of 1,200 numbers, about 1,000 being in operation at the present time. In order that any member on the floor may be notified immediately that there is a call for him, the messages are taken by the doorman at either the Broad street, the Wall street or the New street entrance, and communicated by messenger to the operator in charge of the main keyboard. The member's number is then posted on the annunciator. The member applies to the operator, and is directed to the point from which the enquiry originated. In order to facilitate the calling of members, there is also a system of speaking-tubes, these speaking-tubes leading from the important rooms of the ex-

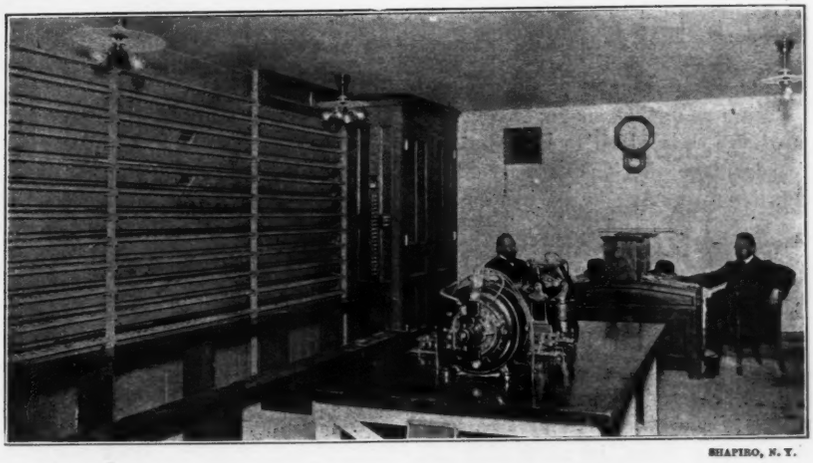

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FIG. 8.—THE ANNUNCIATOR TERMINAL ROOM, SHOWING TERMINAL BOARD AND MOTOR-GENERATORS, STOCK EXCHANGE, NEW YORK CITY.

change, and also from the corridors, and a system of intercommunicating house telephones.

A number of the members find it necessary to have easy access to the telephone

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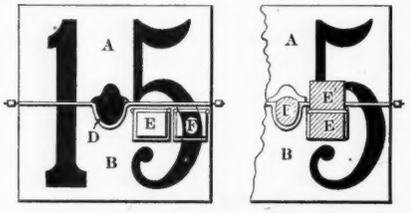
FIG. 9.—THE BOARD ROOM, SHOWING ANNUNCIATOR, PLATFORM FOR MASTER KEYBOARD, TELEPHONE BOOTH, AND PNEUMATIC TUBE SERVICE STATION, STOCK EXCHANGE, NEW YORK CITY.

service during the busy hours of the day, and for this purpose a special arrangement has been provided. A number of booths are placed at the western end of the board room, as may be seen from Fig. 9. Communication is then established between these booths and the broker's annunciator card by push-buttons located in each of the booths. Some of the brokers may be carrying on business for three or four different firms, all of which have telephone booths in this department. In order that the broker may know immediately at which booth he is wanted, a colored disc is shown in conjunction with his number, appearing on the annunciator. There are at present four colored discs being used, thus making a combination of five calls which each broker may take advantage of. The capacity of the annunciator service may be increased to seven special calls and the original number, making eight different calls available. All of the wires used in connection with the annunciator service pass through a terminal room which is located beneath the board room floor, on a level with the street. The terminal board, Fig. 8, in this room is over twenty-one feet long, and the wires from the north side and south side annunciators come to this terminal station through iron conduits. Measuring instruments are located at each end of the terminal board, and by a special system of apparatus, invented by Mr. Rudolph Einbigler, it is possible to locate within twenty or thirty seconds any fault which may develop in the system. In this terminal room, where each number is respectively connected, there are from four to twenty-four wires attached to



FIGS. 10 AND 11.—THE ANNUNCIATOR SHIELD—THE UPPER PART A IS CLOSED OVER THE LOWER PART B.

each number. By the aid of the terminal board and the system of finding

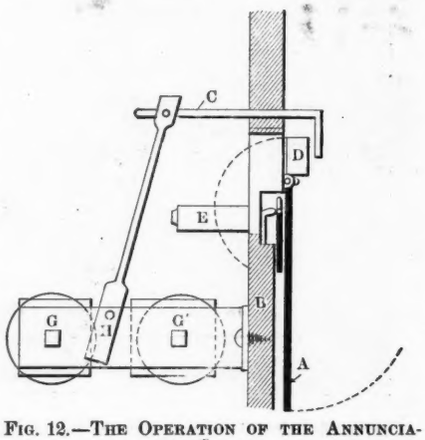


FIG. 12.—THE OPERATION OF THE ANNUNCIATOR SHIELD.

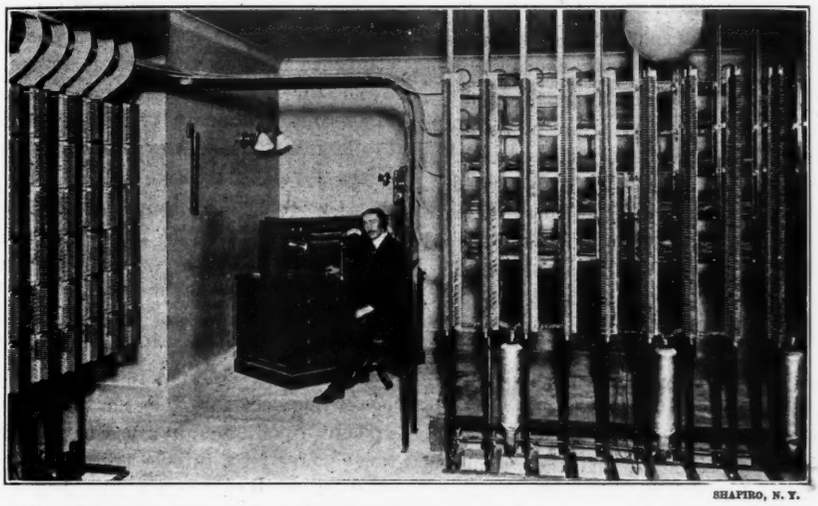
any wire, it is possible to change any number at the shortest notice. There are about 9,000 conductors used in the operation of the annunciator system, requiring about 1,360,000 feet of rubber-covered wire.

One Holtzer-Cabot motor-generator supplies current for the annunciator, a large set of batteries being held in reserve in case of emergency. The system is operated normally on open circuit, the current being used only when the signal is set, and again when it is released.

Figs. 10, 11 and 12 give a good idea of the operation of the annunciator board. A is the upper part of the shield, which is hinged and normally closed over the lower part of the shield, B. The upper part works on a shaft pivoted as seen in the illustration. Behind the board are two magnets, G and G^1. Between these is pivoted an armature, H, which operates a forwardly projecting lever arm, C. When the operator presses a button, the armature, H, is first attracted to the pole-piece on the magnet, G^1. This brings the projecting arm, C, back, which, striking the weighted end, D, of the upper part of the shield, causes it to rotate and assume a position as shown in Fig. 11. When the member whose number corresponds to the signals shown has been properly notified, the operator presses the release button for this member, and the armature, H, is then attracted toward the pole-pieces of the magnet, G. This causes the projecting arm, C, to strike against the back of the upper part of the shield, A, making it fold back over the fixed portion, B. When the button in the telephone booth is manipulated, the actuating mechanism, E, causes the disc to move forward and strike the upper part of the shield, A. The weighted portion, D, as soon as it is over the centre, carries the part, A, to the signaling position, and obviates the necessity of pressing the main keyboard button. The release button in the telephone booth is on the same circuit as the release button on the master keyboard, the operation of either releasing the signal automatically. The entire annunciator system has been designed and installed by Messrs. Einbigler & Adler, of New York city.

The telephone system in the Stock Exchange is novel in many ways, and probably the first and only installation of its kind. There are about 520 booths on the board room floor, with additional instruments in the corridors and at convenient points about the building. The instruments were made up especially for this service, and are about as small as it is possible to make them to meet the requirements of the peculiar service for

which they are used. The installation is primarily a private line exchange, each telephone on the board room floor being connected with the offices of the firm which leases it by private circuits, having no intercommunication with outside lines. On the ground floor of the Stock Exchange building the terminal room of the telephone system is located. This is practically a self-contained central energy exchange. All of the current for the talking, ringing and signaling circuits is generated in this room, and the incoming lines from the subscribers' stations are connected across by the proper intermediaries to the booths on the board room floor. Fig. 14 shows the switchboard in this station, and Fig. 13 the main distributing frame, the intermediate frame, and the wire chief's desk.



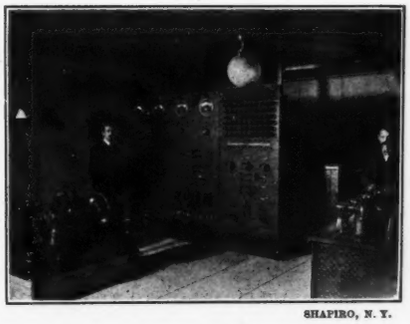
SHAPIRO, N. Y.

FIG. 13.—THE MAIN DISTRIBUTING FRAME, INTERMEDIATE BOARD, AND WIRE CHIEF'S DESK—TELEPHONE EXCHANGE, STOCK EXCHANGE, NEW YORK CITY.

The switchboard is composed of three slate panels, each about three feet wide and seven feet high. The panel at the extreme left is the power board proper. Upon this panel are mounted the starting box handles for controlling the motors of two Western Electric motor generating sets used for charging the storage batteries. There are also switches for taking current for the motors from either the house or the Edison service. On the left-hand panel there is also mounted a voltmeter switch which is used in connection with the voltmeter on this panel to give the reading on any individual cell in either set of batteries, or to give the voltage at the terminals of each generator; and a Weston ammeter which indicates the charging current. On the panel in the centre are mounted the connections for each charging circuit, two fuses being inserted on each of these circuits. There is also an "I. T. E." circuit-breaker on each circuit, with the controlling coils for operating the circuit-breaker in event of the current dropping below a predetermined value.

The equipment is operated on a twelve-volt system. There are twelve cells of the chloride accumulator type, six cells in each set. The switches on the central panel are so arranged that six cells may be charged by one generator, while the six cells in the other set are being discharged, a similar arrangement allowing of six cells in one set being charged by the second generator while the second set of cells is being discharged. On this central panel are mounted regulating switches for the charging current and voltage from either generator, with a standard indicating Weston ammeter and voltmeter.

On the panel at the right the first and second switches leading from the left panel are connected with the main house switch, and the third is connected with the battery discharge. These control the current for the three Western Electric ringing machines, each ringer being controlled by a starting box, the handle of which is manipulated from the face of the right-hand panel. Each ringer has a generating lead to the power board. In connection with these there are one double-throw switch and one single-throw switch, to facilitate the discharge of current in the proper channels. Each lead from the generator is fused before it reaches the switch. The positive side of the general discharge lead comes to a bus-bar on this board, and from this point current is distributed through fuses to each individual circuit, embracing ten telephone instruments. In series with each fuse is a 110-volt, sixteen-candle-power incandescent lamp, inserted between the fuse and the point of use. The twelve cells of storage battery are set up on an insulating platform, and the complete outfit is enclosed in a paneled compartment, so arranged with glass covers and side doors that the cells are readily accessible, but in normal operation there is no escape into the room of the gases generated, these being carried off by a vent and flue at the extreme end of the battery compartment. All of the conductors from the power board to the battery, and from the battery to the fuse board, are led through underground conduits. From the fuse board the circuits are led through retardation coils along cables to the intermediate rack, where, in common with the main lines, the circuits go to the telephones on the board room floor. The wires coming from the subscriber's telephone enter the room by the way of block and underground cables, reaching the central station at the Stock Exchange, where they are brought out and connected through heat coil arresters to the distributing frame. From this point they are distributed across the main frame to horizontal strips, meeting the cables which carry the line to the intermediate frame. From this point the main lines are led to the booth on the board room floor. All of the cables from the intermediate frame to the board room floor are lead-covered, and are run through iron conduits.



SHAPIRO, N. Y.

FIG. 14.—POWER BOARD, MOTOR-GENERATORS, AND RINGERS, TELEPHONE ROOM, STOCK EXCHANGE, NEW YORK CITY.

Fig. 13 shows the wire chief's desk. This is equipped with the standard wire chief's apparatus, a complete outfit being installed for immediately locating any fault which may develop in the system. This exchange maintains its own linemen and troublemen, and is in charge of the wire chief, Mr. F. H. Kilfedder.

In conclusion it is necessary to acknowledge the many courtesies shown by Mr. R. P. Doremus, of the building committee, and in charge of the engineering features; Mr. John H. Dally, the chief engineer; Mr. Charles Deacon, and Messrs. Einbigler, Kilfedder and Diehl.

CONDITIONS OF PROGRESS IN ELECTROCHEMISTRY.[1]

BY JOSEPH W. RICHARDS.

To live is to progress, and a science which does not progress petrifies. As the progress of electrochemistry is only one phase of scientific progress, a clear understanding of the laws governing the latter will teach us the conditions of progress in the former.

Science advances in many ways, along different paths and by different agencies. For the purpose of this discussion, this progress is classified under six heads, which will be considered separately.

DISCOVERY OF NEW FACTS IN ELECTROCHEMICAL SCIENCE.

This was placed as a cornerstone in electrochemistry, giving a freshly flowing current of new electrochemical facts. All the other elements of progress have a chance to exist. The birthplaces are electrical, chemical and physical laboratories; the sponsors are the investigators. The elect among these workers are the professors of electrochemistry, provided with well equipped electrochemical laboratories. They are in the position to do or to direct the most valuable investigations, and are also under the normal obligation to publish to the world all that they discover. In this group may be classified Davy, Faraday, Bunsen, Arrhenius, van't Hoff, Ostwald, Nèrnst and Moissan. There are others of the rank and file following cheerfully the same paths. Our journals teem with the results of new researches, by which the humble worker in one corner gains the knowledge gleaned by many workers and in return contributes what he can.

The German-speaking countries count up alone at their universities and technical schools fifteen chairs of electrochemistry and twelve electrochemical laboratories. These have been the source of the greater part of the advance of electrochemical science in the last ten years. Gratitude and self-interest unite in recommending to the captains of the electrochemical industry, that more such laboratories be built and more such chairs be endowed. The present flourishing condition in America is largely due to foreign trained electrochemists and important literature. Should we not soon begin to establish chairs of electrochemistry and build well equipped laboratories to go with them?

There is, however, another class of investigators which is no less industrious in acquiring facts. This is the army of investigators in the laboratories of our industrial plants. The expense of such work is borne by the corporation for which they labor, and the work itself is in reality an investment. Such workers frequently discover important facts and the employer should feel under obligation, and allow publication of these when the research has achieved its financial purpose.

CLEARER KNOWLEDGE OF THE LAWS CORRELATING THESE FACTS.

By means of facts, discussing and deducing therefrom, we arrive at a knowledge of the laws of the science and the relations governing its various phenomena. Such deductions are the goal of pure science, and the electrochemist not blessed with laboratory facilities has free entrance into this field. He may be only a student, but if he is at the same time a thinker, a compiler, an analyst, with the power of collating, dissecting and deducing, he may in the seclusion of his study discover laws which escape the observation of others less studious, and thus render a service of the highest value to science.

MORE RATIONAL THEORIES OF THE WHY AND WHEREFORE.

As soon as facts accumulate and laws are discerned, the scientist begins to reflect on the why and the wherefore. He commences to search for relations, to imagine connections and to make pictures of the mechanism of the phenomena. Thus, there are theories put forward, some poor and some almost perfect, since, granting their premises, they give an explanation of all observed phenomena.

Such theories are not only allowable, but necessary. But a danger to the development of the science comes when a theory, by being believed too implicitly, becomes a straight-jacket for the growing science.

The fundamental conceptions must always be open to correction and revision. If new facts appear which contradict our theories, let us welcome them, like loyal lovers of the truth.

INCREASING APPLICATION TO INDUSTRIAL NEEDS.

In order not to become a mere code of observed and classified facts, a science must find practical application which increases the comfort, pleasure or wealth of mankind. The whole circle of human industry consists in utilizing the fleeting value of the perishable capacity to labor, linking it with natural forces and thus turning into valuable products natural crude material. The items concerned are crude material, power, brains and industry. Power alone is apt to be regarded as the first desideratum for the success of electrochemical processes, but knowledge, thinking power and industry are more primary factors.

The item of cheap power in manufacturing cost is of variable importance in electrochemical processes. In some it may form three-quarters of the total cost of the process; in others, perhaps only one-quarter. The former are frequently compelled to move to the cheapest power, while the latter, taking into account other considerations, may find it cheaper to locate at more expensive powers. Niagara Falls has drawn the majority of our electrochemical industries, but another source of surplus power is distributed over a large part of our country, from blast furnaces, burning its gases to heat its blast and to raise steam for power. Two-thirds of its gases used for the latter purpose generate just about the power needed for the machinery, an amount equal, on an average, to 2,500 horse-power for a furnace taking 500 tons of iron per day. If the gas thus used was used in gas engines, there would be an average surplus power, over and above the requirements of the furnace itself, of 10,000 horse-power. The gas engine plant needed to produce this power does not cost over $50 per horse-power, which compares favorably with the cost in developing water powers. Thus, there are scattered over the United States, in some of our most flourishing industrial centres, undeveloped powers which aggregate over 1,000,000 horse-power and which could be utilized without any drain on our natural resources.

Other possible sources of power are the waste surplus gases from by-product coking ovens, and the utilization of gas producers using cheap coal.

AN INCREASING DISSEMINATION OF THE LITERATURE AND FACTS OF THE SCIENCE.

No science can progress if it adopts the mediæval practice of the alchemists, and carefully guards its wisdom for the exclusive use of the initiated. Widespread dissemination of the literature of electrochemistry is necessary to progress.

The literature of the science consists of transactions, journals, treatises, monographs and text-books. The transactions of our societies represent the labors of many heads and hands, and the opinions of many minds. They are the reservoirs of information from which the other literature of the science is compiled.

[1] Abstract of presidential address delivered at the third general meeting of the American Electrochemical Society at New York city, April 18, 1903.

Their value is augmented by being printed quickly and distributed.

Our journals serve to keep us posted as to current events, and these should be in the most able hands, for a capable editor can render service of the first importance to all his readers, by culling out and presenting only the best and reliable, and fearlessly scoring the financial shark and the scientific impostor.

Text-books are intended to give beginners their first ideas of electrochemistry, and should be most carefully written. Nothing sticks so permanently in the mind as a correct idea taken in youth from a good book, except, perhaps, an incorrect idea taken from a bad book, and the latter often sticks the hardest. There are entirely too many imperfect text-books. One good one, written by a master, is worth more than all the poor ones put together.

AN INCREASING VISION OF THE POSSIBILITIES OF THE SCIENCE.

If we ask the student of electrochemistry why he chooses this for his life work, he will possibly reply that he believes this is the most promising field for his activities. He may have been attracted by the novelty of what was being achieved. In any case, the knowledge of what is and the vision of what may be, is the magnet which draws recruits and adds to the working forces in our ranks. The enthusiastic worker in his laboratory will say that the principal force keeping him at work is the thought that there is so much to do, so much to find out, and so much promise of achieving great things that he can not but become enthusiastic. The ever-widening vision of an ever-widening field is the reward and the inspiration of every honest worker.

In like manner each of us is inspired and encouraged to high endeavor and imbued with the spirit to do by sight of vision of the possibilities of electrochemical science.

If there is one thing which the Electrochemical Society does of more superlative worth than any other, it is the resultant enlargement of vision which comes to each of its members from the interchange of thought, the sharing of ideas, resulting from its meetings.

Let us all, then, see it as our privilege as well as our duty to promote in every way the interest, the attractiveness and the scientific atmosphere of these meetings, for they are the elixer of life to the development of electrochemistry in America.

National Electric Light Association.

The list of papers to be read at the twenty-sixth convention of the National Electric Light Association, Chicago, Ill., May 26, 27, 28, has been announced as follows:

"Fuel Losses in Furnaces and Boilers, and How to Lessen Them," by Mr. A. Bement.

"Salt as a By-Product," by Mr. Alex Dow.

"Advantages Derived from the Use of One System of Generation and Transmission in One Locality," by Mr. C. L. Edgar.

"Tactful Relations with Customers," by Mr. J. W. Ferguson.

"Relative Advantages of Electrical and Mechanical Methods at Variable Speeds for General Power Service," by Mr. Wm. Cooper.

"First Aid Appliances," by Mr. J. D. McGowan.

"Standard Rates for Transformers," by Mr. John S. Peck.

"Steam Turbines," by Professor Wm. Lispenard Robb.

"The Application of Four-Ampere Series Arc Lamps for Street Lighting," by Mr. J. Henry Hallberg.

"Some Fundamentals of Photometry," by Professor H. E. Clifford.

"Exhibition and Description of the Matthews Integrating Photometer," by Professor Charles P. Matthews.

"Attitude of Employer Toward Benevolent Insurance and Educational Associations Among Employés," by Mr. Arthur Williams.

"District Heating," by Mr. John W. Glidden.

"The Young Engineer and the Electric Lighting Plant," by Charles F. Scott.

Committee reports:

"Report of Editor of Progress," by Mr. T. C. Martin.

"Decorative and Sign Lighting," by Mr. Arthur Williams.

"Unaccounted-for Current," by Mr. L. G. Van Ness.

"Theft of Current," by Mr. R. L. Elliott.

"Office Methods and Accounting," by Mr. W. M. Anthony.

"Photometric Committee," by Mr. H. L. Doherty.

"Committee on Analysis of Flue Gases," by Mr. H. L. Doherty.

Professor Elihu Thomson will also present a paper, and Mr. H. T. Hartman, editor of the question box, has a complete file of subjects for discussion.

New York Electrical Society.

Mr. Bion J. Arnold lectured before the New York Electrical Society on April 29, on the subject of "The Transportation Problem in Chicago and Other Great Cities." The lecture contained an immense amount of valuable material on the subject of surface and subway lines; the unification of the street railway service, either under single control or by the cooperation of several systems under separate control; the one-city one-fare idea; types of rails; terminals; electrolysis; the growth of population and traffic in the past, and estimates as to the future increase of street car traffic.

The following members were elected: N. B. Tretheway, C. G. Young, Jeremiah J. Kennedy, Maurice Hoopes, Percy Foote Cowing, Fred W. Ellen, John B. N. Vanzandt, F. H. Fuller, Fredk. J. Hall, Wm. F. Bissing, Wilson S. Howell, Frederick Arthur Goetze, Joseph W. Tracy, Martin J. Insull, George T. Conkling, Eugene P. Etzel, John D. Keily, Anthony L. Noone, Harry C. Hall, L. F. Bentley and R. R. Hutton.

The lecture was preceded by a business session, during which the amendments to the constitution and by-laws, approved by the executive committee, were submitted to the society for discussion, prior to their being voted on at the May meeting. Two amendments were freely discussed, one to make the president eligible for reelection for one year, but at no future time, and the other bearing on the appointment by the president of the nominating committee. The sentiment of the meeting, as expressed by several members, was that the society should follow the lead of most other societies at the present time, and notably that of the American Institute of Electrical Engineers, and make the president ineligible for immediate reelection. In regard to the appointment of a nominating committee, from the trend of the discussion there seems to be a markedly growing belief that some provision for giving the society at large an equal representation with the executive committee, and introducing as an added element of stability one or, perhaps, more of the past-presidents of the society, would be more satisfactory in its results than the method now proposed, which provides that the president shall appoint a nominating committee of seven, four of whom shall be members of the executive committee, and that this committee, in conjunction with the president as a member *ex-officio*, shall prepare a ticket.

Plans for an Engineering Building.

A meeting of the presidents, or their representatives, of the following organizations—the American Society of Civil Engineers, the American Institute of Mining Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, and the Engineers' Club—was held at the Engineers' Club, New York city, April 30, 1903, to receive from a committee to whom certain preliminary arrangements had been entrusted a communication from Mr. Andrew Carnegie, addressed to the several societies and the club, proposing to erect a Union Engineers' Building.

The suggestion for a common engineering building is not new, but the plan first began to take definite shape after the recent Library Dinner, on February 9, 1903, of the American Institute of Electrical Engineers, which was tendered to Mr. Andrew Carnegie. Immediately following this dinner Mr. Carnegie sent for Mr. Charles F. Scott and Mr. Calvin W. Rice, requesting them to call upon him; and at the interview which followed, Mr. Carnegie said that he had enjoyed the dinner, and had been much interested in the work of the engineering societies, and also in the suggestion of a common building. He asked many questions concerning the status of the buildings and the incomes of the various organizations, and was impressed with what had already been done and the possibilities for future development. He requested Mr. Scott and Mr. Rice to ascertain what land would cost to accommodate an adequate building, and said he was ready to put up the building if the societies provided the land.

Shortly after this interview a meeting of prominent members of the various engineering societies was held at the Engineers' Club, and the matter was considered. Following this, a committee waited upon Mr. Carnegie, and discussed the matter freely with him. Mr. Carnegie again expressed his readiness to give the funds for the erection of a building, provided the several societies could make certain arrangements with respect to the necessary ground; and he sent the following letter:

New York, Feb. 14, 1903.

Gentlemen of the American Society Civil Engineers, American Society Mechanical Engineers, American Institute Electrical Engineers, and the Engineers' Club:

It gives me great pleasure to give, say, one million dollars, to erect a suitable Union Building for you all, as the same may be needed.

With best wishes,
Truly yours,
(Signed) Andrew Carnegie.

At the meeting held April 30, 1903, more detailed plans were formulated, outlining the work to be done in order that Mr. Carnegie's generous gift might be accepted.

A plan of organization has been prepared by Mr. William A. Redding, chairman of the house committee of the Engineer's Club. The property on the south side of Fortieth street, 50 feet wide and nearly 100 feet deep, has recently been purchased by the Engineers' Realty Company as a site for a new club house for the Engineers' Club. Written options have been acquired to purchase before July 1, 1903, five contiguous properties on the north side of Thirty-ninth street, west of Fifth avenue, which are immediately in the rear of the above-mentioned property on Fortieth street, and the aggregate width of which is 125 feet, and the depth of which is nearly 100 feet. These five properties are to be purchased by the American Society of Civil Engineers, the American Society of Mechanical Engineers, the American Institute of Mining Engineers, the American Institute of Electrical Engineers, and such other societies of engineers as shall be determined upon. The property should be acquired in the following way: The Engineers' Club should purchase from the Engineers' Realty Company the property on Fortieth street, subject to a mortgage of $110,000 and in payment therefor should give the Engineers' Realty Company 1,150 bonds of the par value of $100 each, executed by the club, to be payable in twenty years, bearing interest at four per cent. The four national societies should purchase the five properties on Thirty-ninth street, and accept a conveyance of them in fee simple to these societies as tenants in common, share and share alike, the cost of the purchase of these properties to be paid by these four societies share and share alike. Each society may pay in cash or may execute a bond, and give a mortgage to secure its interest on these properties. The character and arrangement of the building should be determined by a joint committee composed of the president and two other members of each of the organizations that shall unite in accepting the gift of Mr. Carnegie. This joint committee should have power to determine by an affirmative vote of at least two-thirds of all the members, the character and arrangement of the buildings to be erected, and should also have power to obtain from competent architects plans and specifications, to approve of them, and to make and enter into contracts for the erection of buildings.

Vesting in such a joint committee these powers would avoid much diversity of opinion and controversy that would arise should the plans have to be submitted to each organization for approval.

The building to be erected on Fortieth street should be occupied by the Engineers' Club exclusively. The joint committee should have power to determine what portion of the building to be erected on the Thirty-ninth street site should be occupied by each of the four national societies, and what proportion of that building should be reserved for the occupancy of other societies of engineers that shall be permitted to locate therein.

The building should have a large assembly hall, available for lectures and for the holding of general conventions of the engineering societies. A number of smaller halls to accommodate gatherings will be suitable for monthly meetings of the societies. The libraries of the several engineering societies should be placed in adjacent rooms or alcoves. Rooms will be available for reading and writing.

There should be a governing body to prescribe rules and regulations for the use of the libraries and auditoriums and to fix dates. This should be composed of three members elected annually by the council of each of the four national societies. The independence and integrity of each organization should be preserved thoroughly, and nothing should be done to affect or interfere with it. Resolutions are proposed to bring the five organizations into this enterprise, to express to Mr. Carnegie the high appreciation of his generous gift, and to appoint a committee, composed of the president and two members of each organization, to carry out the work outlined.

The encouraging outlook for an engineering building is a source of special gratification to members of the American Institute of Electrical Engineers, as the present promise of success is due largely to the efforts of Mr. Calvin W. Rice, chairman of the Institute building committee, and President Charles F. Scott. These gentlemen were ably assisted by the other members of the Institute building committee, Dr. S. S. Wheeler, Mr. W. D. Weaver and Mr. C. O. Mailloux.

The Liebig Centennial Celebration.

The New York section of the Verein Deutscher Chemiker will celebrate the centennial birthday of Justus Liebig on May 12, 1903. The exercises will be held in the assembly hall of the Chemists' Club, 108 West Fifty-fifth street, New York city, beginning promptly at 8.30 P. M.

Professor Ira Remsen, president of Johns Hopkins University, and Professor W. H. Brewer, of Yale University, will deliver orations. Dr. C. Duisberg, vice-president of the parent society, and Professor Charles S. Chandler, of Columbia University, will address the meeting. The members of the American Chemical Society, the Society of Chemical Industry, the American Electrochemical Society and the Chemists' Club are cordially invited to this celebration.

The South Lancashire Electric Tramways, England.

From Our Special Correspondent.

THE most comprehensive system of electric tramways in Great Britain has just been put into serious operation in South Lancashire, and the magnitude of its sphere of working may be well judged from the route map herewith. The mere fact of the opening of a large percentage of the lines authorized to the company, however, is of little importance, comparatively, when the ramifications of the system generally and its relations with existing modes of travel are taken into consideration. At the present time no undertaking of the same character in the kingdom is in such complete continuity with its immediate competitors, and this will be emphasized later on in this article.

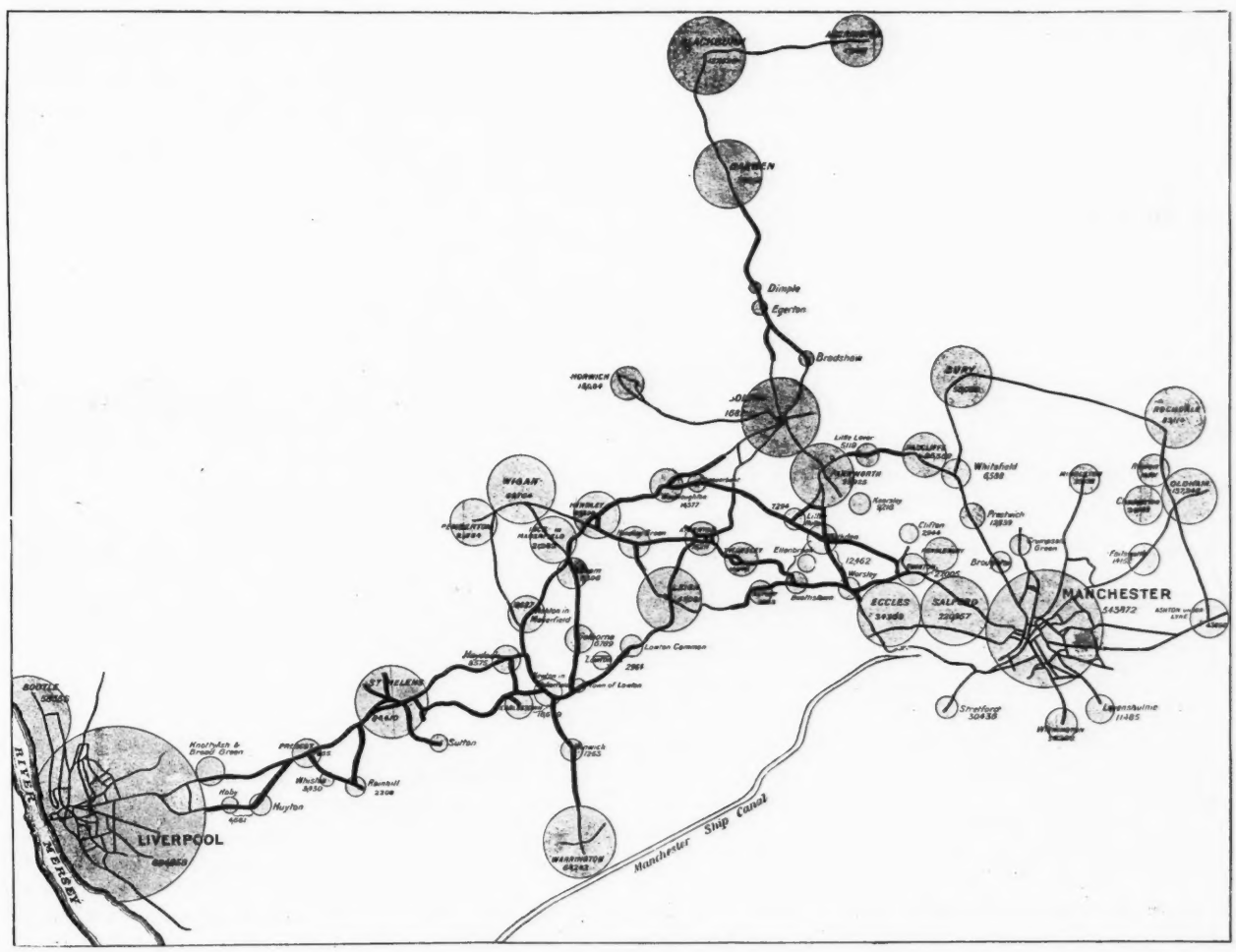


DIAGRAM SHOWING CONNECTIONS OF SOUTH LANCASHIRE TRAMWAYS COMPANY'S SYSTEM, WITH THE PRINCIPAL TOWNS OF SOUTH LANCASHIRE.

The South Lancashire Tramways Company was promoted in the year 1900, for the purpose of seeking parliamentary powers for constructing electric tramways around the large commercial area of South Lancashire, and to connect up the more important towns, which had hitherto been, to all intents and purposes, isolated and strongly in need of an up-to-date system of intercommunication; the only other facilities of the kind, beyond a somewhat sparse steam railway service, being a service of single-horse omnibuses. It was felt, therefore, that the development of the various localities, shown on the map, was being much retarded, and the inauguration of this great scheme, of which thirty-two miles are in very satisfactory operation, is viewed with great favor everywhere in that area. In addition, a light railway order was obtained for a tramway between, and the line was opened in June, 1902, being in the South Lancashire Company's hands. Altogether 550 miles of tramways will eventually be interconnected, serving a population of 5,000,000.

The first section of the company's tramway lines, ten miles in length, was opened in October last year, establishing direct connection between Lowton, Leigh, Atherton, Tyldesley and Bolton. Another line was opened on February 7 of this year, running from Atherton to Hindley, and the link between Hindley and Haydock, now being completed, brings Liverpool into direct tramway connection with Bolton and Wigan *via* the intervening system of St. Helens. The next constructional scheme provides for an extension from Bolton to Salford, and from Salford to Leigh, and Lowton to St. Helens. The company has powers to construct about 115 miles of tramways, giving a double connection between Liverpool and Man-

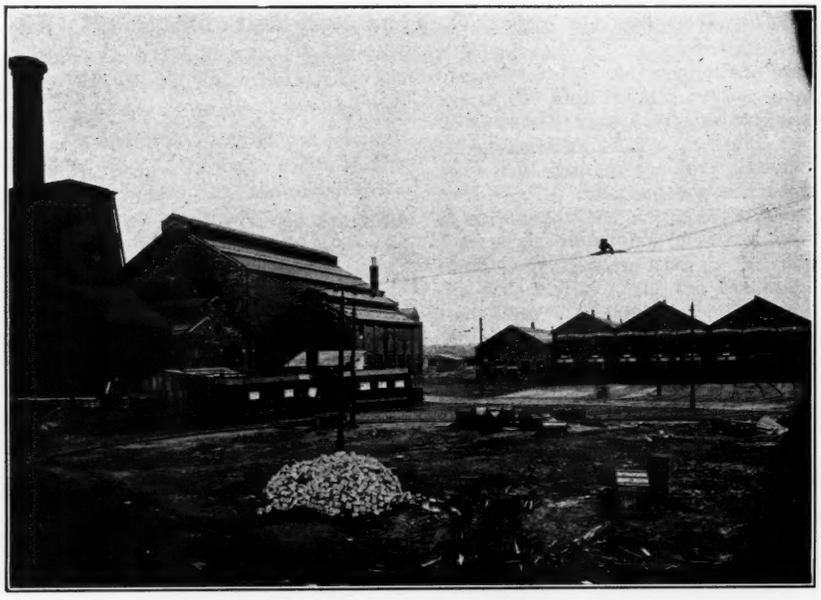
chester by a sort of triangular route and linking up over thirty important towns in a most congested manufacturing area, including Bolton, Wigan, St. Helens, Prescott, Warrington and Salford. The company's cars now start from the pierhead, Liverpool, and run over the latter corporation's lines to Knotty Ash, where the first section of the company's lines is reached as well as open country, and by means of the map the route can be traced. Running powers have been granted over the municipal electric tramways of Liverpool, Manchester, Salford, Bolton, and, in fact, all the large towns shown on the map.

Among many innovations introduced into the system, compared with what has previously been attempted over here, are arrangements with the Great Central Railway Company, a steam line which runs down into London, whereby through booking has been established. A notable feature, too, is the carriage of all kinds of light and heavy merchandise, the latter of which it is intended to convey during the night. The fact is also both remarkable and interesting that the lines have been laid out as to pass the doors of the principal mills, factories and collieries in the district, thus enhancing the value of such a heavy goods service. A parcel service has already been started, and goods up to fifty-six pounds in weight are collected by the cars at all points throughout the route, and delivered hourly by agents in the outlying districts.

This much having been said of the commercial and general aspects of the system, the technical character of the construction work now in operation will be interesting.

Dealing first with the generating station, this is situated at Howe Bridge, Atherton, in a practically central position. The engine room is 60 feet wide by 125 feet long, and provision is made for considerable extension of the building, in order to accommodate the additional plant which will be required for supplying power to the, at present, unconstructed parts of the system.

The present power station buildings are fully occupied by the plant now erected, comprising two 500-kilowatt, 7,500-volt, two-phase alternators, running at a speed of 100 revolutions per minute; one 500-kilowatt traction generator; one 250-kilowatt traction generator; one 250-kilowatt synchronous motor-generator, as well as positive, negative, and reversible battery boosters. The alternators are mounted between the cranks of the engines. The capacity of the engines is such that they give a continuous output equivalent to 500 kilowatts, with twenty-five per cent overload, for a period of two hours, and fifty per cent overload momentarily. The normal working pressure is 160 pounds per square inch. They are vertical machines, with four seated lift valves at the high-pressure cylinders, and Corliss valves on the low-pressure side, and they run condensing. Forced lubrication is employed for the working parts, with oil pumps worked by means of eccentrics from off the top gallery. The arrangement of the engines is such that access to every one of them may be obtained without descending to the ground level.



EXTERIOR OF THE POWER-HOUSE, SOUTH LANCASHIRE TRAMWAYS COMPANY.

The alternating-current generators, mounted between the cranks of these engines, are capable of giving 500 kilowatts continuously and twenty-five per cent overload for two hours. The flywheel is extra heavy on account of the fluctuating nature of the load these machines will be expected to carry, and in order to secure the necessary uniformity of turning for proper parallel running. The terminal pressure is 7,500 volts per phase and the frequency fifty cycles per second when running at a speed of 100 revolutions per minute. The exciters are rope driven off the flywheel. The high-tension generators transmit power to the substation plant, and in addition may be used to drive a synchronous motor-generator set in the power station when the steam-driven traction generators are shut down. There is also a 500-kilowatt, compound-wound, standard traction generator mounted between the cranks of a cross-compound engine. The design of this machine and also the whole of the continuous-current machines, is such that sparkless running is obtained between no load and full load without shifting the position of the brushes. A special switch pillar is placed by the side of the field yoke in order that the compounding coils may be cut out when necessary, so that the generator may be used as a shunt machine for battery charging purposes, in which case the reversible booster (which will be referred to later) will be placed in circuit. The 250-kilowatt steam-driven traction generator is similar to the 500-kilowatt machine described above, it being also mounted between the cranks of a cross-compound engine with the armature spider rigidly bolted to a flywheel five tons in weight. The set runs at 150 revolutions per minute, and will stand an overload of twenty-five per cent for two hours and fifty per cent momentarily.

The 250-kilowatt motor-generator runs at a speed of 300 revolutions per minute, and may be used as a synchronous motor, driving its generator either as a shunt or compound-wound machine, a switch pillar being fixed on the bed-plate for cutting out the compound windings when necessary. Or, alternatively, it may be used as a continuous-current motor, driving the alternating machine as a two-phase generator with 7,500 volts per phase, since, when a small load only is on the substation, it will be more economical to run in this manner than

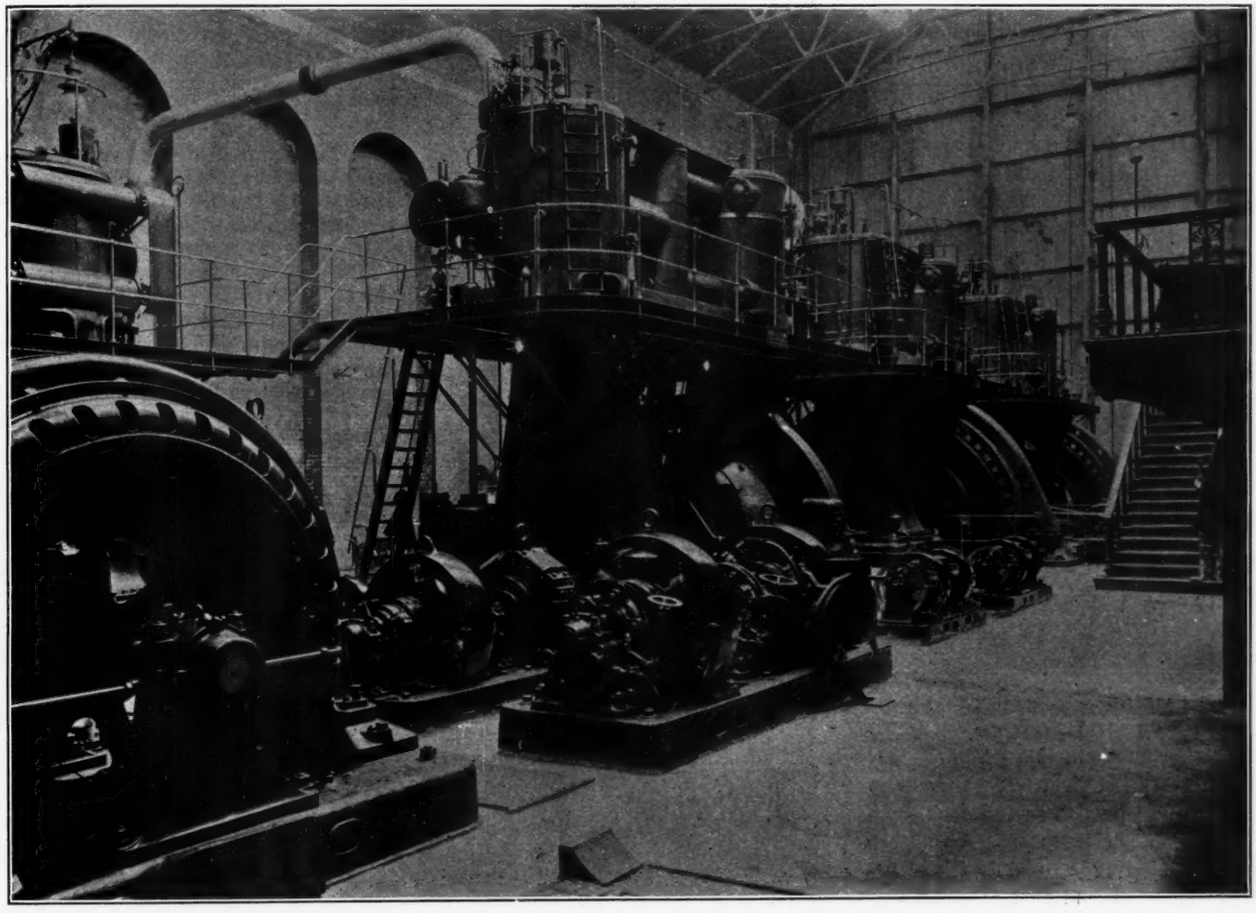
to keep one of the large 500-kilowatt alternators running. In this motor-generator set two standard machines have been coupled together by means of a flexible coupling.

Two surface condensing plants have been installed, each capable of dealing with 19,000 pounds of steam per hour, and another will shortly be erected. An extra large cooling tower has also been placed at the extreme end of the buildings.

The auxiliary machinery in the station is not without interest. Firstly, there will be one fifty-six-kilowatt positive feeder booster driven by a continuous-current motor at a speed of 550 revolutions per minute, the two being mounted together on one bed-plate, each with an independent field. The generator is wound for forty volts at fifty-six kilowatts, and also gives a varying output from zero to the maximum amperes with a proportional use in volts. This machine is capable of giving twenty-five per cent overload for a period of two hours, and fifty per cent overload with voltage and current above the normal output for short periods not exceeding ten minutes. The other auxiliaries are two eight-kilowatt negative feeder boosters, and are of ten-kilowatt capacity; also a small portable milking motor booster for accumulators.

There is also a forty-kilowatt battery-charging booster, which is of the reversible type and works automatically, either charging or discharging the battery, keeping the voltage on the line constant. The automatic regulating portion is self-contained, and comprises a small motor with controlling gear, etc., mounted on the switchboard gallery. The amount of boost can be regulated at will by the switchboard attendant by means of a small auxiliary resistance. This is the only operation of the apparatus, however, which is not entirely automatic.

The substation plant comprises certain auxiliary machines similar, excepting as regards to size and output, to those in the generating station; but an interesting feature in this plant is the 150-kilowatt high-tension motor-generating sets. The description of the 250-kilowatt set given above, in connection with the power-house plant, applies equally well to these machines—three of which are being provided—with the exception of the following points; firstly, the two are mounted together on one bed-plate and rigidly coupled together; secondly, instead of a switch pillar separate from the machine, the equalizer switch and also that used for cutting out the series winding, is each fixed on the machine carcase. Under ordinary conditions of working, these sets will be used as synchronous motor-generators, the generators being used as a shunt machine in conjunction with a reversible booster and batteries of large capacity. With this arrangement, the load on the motor-generator, and consequently on the power-house, is kept practically constant, since when no cars are taking current, the extra power will be used for charging the battery. When, however, the cars are started and running on the line and a greater demand for power takes place, part is supplied by the motor-generator and part by the battery. The amount of power which the cars can call upon is, therefore, equivalent to more than double the output of one motor-generator set, the whole

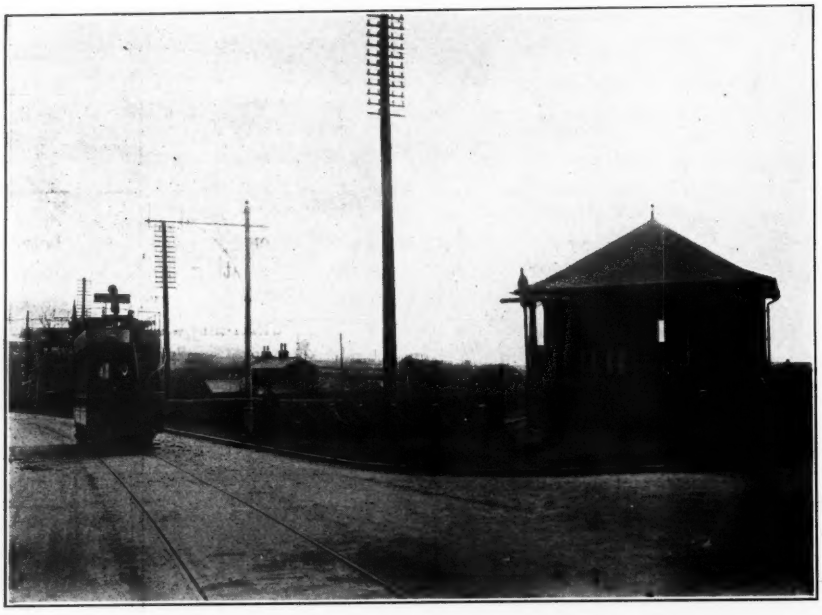


ENGINE ROOM, POWER-HOUSE, SOUTH LANCASHIRE TRAMWAYS COMPANY.

of the machinery working automatically when connected up with reversible booster. In such a case, the electromotive force between the bus-bars is kept constant with the drops in the feeders and lines, made up with the positive boosters. A booster is also inserted in circuit with the negative feeders, the fields of these machines having several series turns traversed by the current passing to the positive feeders. When it is not desired to use the battery or reversible boosters, the compound winding of the continuous-current generators is switched into circuit, the machines then operating as ordinary compound-wound traction generators.

Coming back to the boiler house of the main power station, this contains four Lancashire boilers, eight feet six inches in diameter and thirty-three feet long, each fitted with automatic stokers. A 360-tube economizer, giving a total heating surface of 3,600 feet, and a water capacity of 2,350 gallons, is also erected there. An extension of this may be made when necessary. There is also a riveted steel-plate, brick-lined chimney stack 150 feet in height, induced draught being applied by means of an electrically-driven fan. A separate pump room adjoins the boiler house, containing three vertical steam-driven feed pumps, each of which is capable of delivering 3,000 gallons of water per hour to the boilers. The feed water is obtained from the Manchester corporation water mains and delivered into two large cast-iron tanks, placed over the pump room, each having a capacity of 20,000 gallons, one being held in reserve. The exhaust steam from the auxiliary plant passes through a copper worm, placed in one of the feed tanks, and thus imparts its remaining heat to the feed water. In case of a temporary failure of the main water supply, a small electrically-driven centrifugal pump is arranged to pump water from the tank at the bottom of the cooling tower to the feed tanks. All the piping is duplicated and the main steam piping in the boiler house is arranged on the ring system.

The battery of accumulators consists of 240 cells, capable of giving 265 amperes for six hours, 981 amperes for one hour, or 1,400 amperes for short periods. The object of installing this has been to equalize the load on the direct-current generators, and boosters are used for charging.



SWITCH-HOUSE, PRESTON, SOUTH LANCASHIRE TRAMWAYS COMPANY.

The switchboards, both for the high-tension and low-tension circuits, are placed on a conveniently raised platform on one of the long sides of the central power-house.

The high-tension cables are drawn into stoneware pipes, while the low-tension feeders are mostly laid on the solid system in troughs. The high-tension feeders which convey energy to the substations have three conductors, with a common return for the two phases. Two conductors are arranged as a twin cable, and the return encircles the whole as an outer conductor, which is earthed at the central station.

The track is laid to a gauge of four feet eight and one-half inches, six-inch girder rails being employed, weighing ninety pounds per yard in forty-five-foot lengths. The track principally consists of single line with passing places, while in the busier parts of the route the up and down lines are carried through different streets —as nearly parallel as could be—to facilitate the traffic as much as possible. A notable feature in connection with the track construction over a considerable length of the present lines is the adoption of longitudinal sleepers under the rails as recommended by Colonel Yorke after his visit to the United States, a method which, it is hoped, will tend to noiseless running and the reduction of vibration.

The cars are of the double-deck, four-wheel type, seating accommodation being provided for thirty-three passengers outside and twenty-two inside; fifty-five in all. The lighting of the cars is carried out in an efficient manner, the lamps being fitted with handsome cut-glass globes and ornamental brass globe carriers. A powerful headlight is also carried.

The system of overhead equipment is almost entirely that of side poles with brackets, and the swiveling trolley is used. Every alternate pole carries an incandescent lamp, the company having undertaken to thus light the route in return for certain concessions on the part of the local authorities.

London, April 25.

A Demonstration of Wireless Telegraphy.

A practical demonstration of its system of wireless telegraphy was made at the offices of the De Forest Wireless Telegraph Company, 86 Wall street, New York city, on April 27. Sending and receiving sets were set up in different rooms, with miniature antennæ, and messages written by visitors were sent from one room to the other accurately and with ease.

The De Forest system uses an alternating current, furnished by a small motor-generator, and raised to a high potential by a transformer, for setting up the electrical oscillations in the sending antenna. The receiving station consists of an antenna, a suitably adjusted receiving circuit, and the De Forest anti-coherer. This system is being tested practically, and over twenty stations are already erected. The federal government has equipped six stations with this apparatus.

The manufacture of artificial corundum consists, in a general way, of the conversion of the mineral bauxite (a hydrous aluminum oxide) into corundum by means of intense heat and great pressure in an electrical furnace.

SAFETY DEVICES IN CENTRAL STATIONS AND SUBSTATIONS.[1]

BY PHILIP TORCHIO.

(Concluded.)

SUBSTATION.

24. Separate lines entering substations should preferably be operated independently, laying out independent high-tension busses and transforming apparatus on each line, the transformed current being delivered either to a common set of bus-bars or to independent sets of bus-bars, if the service will allow of this subdivision. In rotary substations, while the rotaries operate in parallel on the direct-current side, they can be fed from independent high-tension lines not operated in synchronism. This allows feeding each substation from different groups of generators at the generating station, or even from different generating stations. In the case of alternating-current stations with transformers feeding into a common secondary set of bus-bars, the primary lines must necessarily be operated in parallel, and therefore from same bus-bars at the generating station. This prevents us from attaining the advantages of duplicate lines and independent sources of supply, as in the case of rotary substation. For this reason, in alternating-current systems of secondary distribution, as extensively used in water power plants, the adoption of independent groups of generators and independent feeding lines to important centres of distribution is not common. In important cases it may be advantageous to subdivide the customers' supply on different circuits fed from independent lines and transformers operated from different sources of supply. The New York Edison Company operates at present the generators at its Waterside station in two independent groups and whenever a substation has more than one rotary converter in service, the several rotaries are divided among different feeders, fed from different groups of generators at the generating station. The rotary converters being operated in parallel on the direct-current side, the distribution of loads between different feeders and consequently between groups of generators is easily and perfectly accomplished. This distribution is regulated by the system operator at the station, who instructs each substation how to subdivide the loads among the rotaries. The system is laid out to still further subdivide the groups of generators, if the further addition of generators will make it desirable.

25. Receiving lines should be equipped with oil switches and overload relays with variable time limit in inverse proportion to amount of current. When more than one line is feeding a common high-tension bus or independent transforming apparatus operating in parallel on the low-tension side (for instance, rotary converters), each line should also be equipped with reverse current relays, with variable time limit in inverse proportion to the amount of current, the time limit for these relays being a fraction of the time for the overload relay. Reverse current relays without time limit are too sensitive to momentary irregularities on high-tension system and cause trouble on this account.

26. Inside the substations all high-tension wiring and construction should be laid out along the same lines mentioned in case of generating station. Also, the low-tension apparatus and connections should be properly laid out, avoiding crowding and crossing of cables, keeping cables of different polarities separate, and protecting them by means of ducts, septums and pipes as much as possible.

26A. On very high-voltage receiving stations, the closing of high-tension switches on transformers subjects them to heavy strains which can, in most cases, be avoided by making alive the transformers from the low-tension side, if the common bus-bars are already led from another set of transformers, it may be advisable to leave the high-tension side of transformers closed all the time, especially in water power plants.

27. For protection of lines from overloads or short-circuits on transforming apparatus of large capacities, oil switches with overload relays should be considered preferable to high-tension fuses. The switches should be of proper capacity and should be equipped with locking relays for overloads, exceeding the safe breaking capacity to avoid blowing up the oil switch. The breaking capacity of an oil switch will to a great extent depend not only on the character of load, but also on the amount of power back of the short-circuit.

28. Compound wound rotary converters and eventually also plain shunt wound rotary converters operated in parallel on a common direct-current bus should be protected by some speed limit device to trip the alternating-current and direct-current circuit-breakers on the rotary, when speed exceeds the normal by a certain fixed percentage. The sample shown was a speed limit device developed by the company with which the writer is connected, in conjunction with a firm which manufactures measuring instruments, adopting its standard mechanism for speed indicators.

29. It is desirable to protect the direct-current side of all rotary converters with circuit-breakers to operate in connection with the speed limit device above mentioned, and also in connection with a reverse current relay on the direct-current side of the rotary. This reverse current relay should be equipped with a variable time element in inverse proportion to the amount of reverse current; direct-current overload relays seem to be unnecessary.

30. All relays at different points of the system and their time elements must be properly adjusted, to operate the different circuit-breakers in the proper order, so that if a trouble is once cleared by the opening of certain circuit-breakers, the other relays themselves in the normal position, leaving the rest of the system in operation.

31. Emergency connections between different generating stations are considered desirable and have found favor in connecting different water power plants and also in connecting large generating stations in the same city, as in New York.

32. Of first importance in a lighting situation in a large city is the equipment of storage batteries at every substation. One large New York company, for instance, has installed or under contract twenty-two 8,000-ampere-hour 135-volt batteries, and more may be installed in the future.

33. In closing this list of safeguards, it may be added that in all high-tension work, great care should be used in applying tests to the apparatus, especially in making insulation tests on generators, cables, line and transforming apparatus. Breakdown tests can be made on samples, but it is unwise to strain unnecessarily the insulation of the complete plant near the breakdown point. Close inspection of the installation will finally give more satisfactory results than loose inspection and severe tests.

[1] A paper read at the 176th meeting of the American Institute of Electrical Engineers, New York, April 24, 1903.

The International Association of Municipal Electricians.

The annual year book of the International Association of Municipal Electricians is being distributed. This contains the proceedings of the recent convention held at Richmond, Va. Illustrations of the prominent members of the association and a list of the members are added.

MULTIPLE VERSUS INDEPENDENT OPERATION OF UNITS AND CENTRAL STATIONS.[1]

BY PETER JUNKERSFELD.

The tremendous development in the application of electricity has opened immense fields, which to central station men are continually presenting new problems and graver responsibilities. In all centres of human activity the extended use of electricity is closely associated with the success, well-being and comfort of the public, as well as of individuals. The home, club and hotel; the office, factory and mercantile establishment; the church, theatre and public place; the streets at night, and the great transportation systems—all these are thrown into confusion and disorder on even a slight interruption in the supply of electrical energy.

All members of the Institute are more or less familiar with central station systems, the principal features of which, in the larger cities at least, have been developed along fairly uniform lines. The many practical difficulties of operation, largely influenced by local conditions, are matters of vital importance from both commercial and engineering standpoints. The object of this paper is to call attention to some of these difficulties, with the hope that this will result in a full and profitable discussion.

The direct-current systems of generation and distribution for lighting and general power, and for street railway work, are inherently somewhat elastic. Satisfactory multiple operation of generating units, thus giving a high average station economy, was early accomplished. In large cities the adjacent systems supplied from different stations were gradually tied together, and resulted usually in a large network of interconnected mains supplied at points of greatest density of load by feeders from the nearest generating stations. The equalizing effect between different points of network greatly increased the stability of such systems, which are often further improved by the use of storage batteries properly distributed.

The quality and continuity of direct-current service with this arrangement, has, in most cases, been very satisfactory. However, on account of the heavy fixed charges and losses in operating a large number of small generating stations—many with necessarily poor economy—the limitations in reducing cost of production were very serious indeed.

In the largest cities, having a rapidly increasing load, operating costs have been considerably reduced by alternating-current generation, high-potential transmission, and rotary-converter substations. While these transmission and conversion systems have been developed and fairly well standardized as to general features, there is often still much to be desired in their operation. Systems operating with synchronous generating and converting apparatus and delivering current to the more elastic direct-current network, are especially sensitive to any irregularity in the operation of the prime mover itself or in any of the transmission or conversion units. It is not to be understood that the central station service in large cities is less reliable than before, but that a peculiarly unfortunate feature has been introduced. This temporary disadvantage has in most cases been more than offset by decided improvements and safeguards affecting the continuity of central station service.

The primary cause of trouble may usually be traced to the failure or unsatisfactory performance of apparatus; the mistakes or the inattention of men handling apparatus; or mechanical injury and interference from some exterior source. Troubles of one kind or another, even with the best modern systems, are always possible on the many different links between coal-pile and translating device. In a large central station system supplying direct current, these links might be enumerated and troubles classified as follows:

Mains and services.
Low-tension feeders.
Substation apparatus.
High-tension transmission lines.
Generator, prime mover and auxiliaries.
Steam supply.

Troubles in wiring or translating devices on consumer's premises are usually more directly under the control of the consumer than of the central station.

These different classes of central station troubles are all more or less liable to occur, but the prevalence of any one class or number of classes of trouble depends upon the character of the different installations, and on local operating conditions. In the discussion of these different classes of trouble the writer would, as a matter of illustration, refer to conditions in Chicago, where all twenty-five-cycle, high-potential transmission and direct-current distribution is underground. In the outlying districts the four-wire, three-phase, sixty-cycle distribution is overhead.

Mains and Services—Formerly Edison tube was principally used for all underground mains. The more recent practice has been to use, largely, cables in conduit, giving less trouble than the Edison tube, which is true also of service. However, miles and miles of the old tube mains are in service to-day, and must necessarily remain in service for years to come.

Any trouble, either on mains or services, is usually confined to a comparatively small area by the blowing of strips in the feeder junction boxes. The total amount of current that could be "pumped" into such a short-circuit is limited by the drop in mains and feeders, at least back to the substation bus-bars. Obviously, the duration of such a short-circuit depends on the condition and relative carrying capacity of the "short" and the fuse strips back of it. The drop in mains may be such that it is impossible to deliver enough current to burn off the trouble or blow the fuse strips. These cases, while rare, are very annoying. Sometimes they will "clear" only to start again at an unexpected time, occasionally even making it necessary to remove junction box strips and thus cut out the troublesome section until permanent repairs can be made.

Low-Tension Feeders—On account of the larger carrying capacity the energy delivered on short-circuit is very much greater in feeders than in mains. The total length of conductor in feeders being much less than in mains, the number of troubles with equally good construction are correspondingly less. Furthermore, instead of tubes, cables have been very generally used for several years. This improved construction makes the actual number of feeder troubles still less. Serious trouble on feeders, when it does occur, however, obviously affects a much larger area than trouble in mains. The extent of area affected depends also on the arrangement of bus-bars and class of apparatus in station or substation.

Substation Apparatus—In substations supplying direct current, rotary converters with their accompanying step-down transformers and potential regulators, are used almost exclusively. The direct-current ends of these rotary converters are often worked in multiple with an old generating station, at least during the peak hours of one or two months in the early winter. A storage battery with end-cell switches for discharging on two or sometimes three different potentials is an

[1] A paper read at the 176th meeting of the American Institute of Electrical Engineers, New York, April 24, 1903.

important adjunct to a substation. The batteries in all substations are discharged simultaneously at time of peak on principal generating station, or in an emergency; at all other times they are allowed to float on system. They are charged either by using a booster or direct from a rotary converter equipped with sufficient regulator and transformer capacity for working at the higher voltage necessary for charging.

Even in a substation having a storage battery and a subsidiary steam plant, all of the annual kilowatt-hour output, except a few per cent, is supplied to distribution system through the rotary converter. Special precautions are necessary to guard against interruption of service, as the radius of possible transmission of large powers in case of trouble is very much greater than in the case of services, mains or feeders.

The characteristics of a rotary converter are such that it will carry an enormous overload with very little drop in voltage. Serious troubles or short-circuits, whether they occur in the rotary converter and accessories, in the direct-current connections or in the alternating-current connections, will be violent and are liable to be destructive unless the damaged unit can be quickly and effectually disconnected, both from the alternating-current transmission and the direct-current distribution systems. The localizing of trouble and the effectiveness of disconnecting depend on the arrangement of the alternating-current bus-bars and the automatic safety devices.

The practice of operating practically all units on a single set of bus-bars, at least during long-hour light-load period in the direct-current generating stations, undoubtedly had some influence on the earlier substation bus-bar arrangements. In many large substations all rotaries are operated from one set of bus-bars; in others they can be operated on either one of two sets of bus-bars. Another arrangement consists in running all rotaries from a single bus-bar arranged with disconnective knife switches, so that each rotary or group of rotaries could be operated independently from its own transmission lines. An improvement consists in replacing the disconnective knife switches with remotely controlled oil switches.

With the latter arrangement, each rotary or group of rotaries can be operated all in multiple if necessary or advisable, and be quickly sectionalized in case of trouble on any one transmission or conversion unit. An example is shown in Fig. 1, which gives the scheme of principal connections in a substation that was put into service about one year ago. There are twelve 500-kilowatt rotary converters arranged in three groups of four, each group supplied from its own high-tension line and delivering current to its own section of the direct-current bus-bars. The incoming lines, apparatus, cable connections and switchboards, and the low-tension feeders to street, are all located and arranged to prevent a bad burnout spreading from one group to another.

On each rotary converter there is mounted a direct-current circuit-breaker operated only by means of a 125-volt trip-coil. A centrifugal speed-limit device on shaft closes the trip-coil circuit, thus disconnecting the rotary converter from direct-current bus-bars, and preventing its running away, the causes of which are well known. A reverse-current device also trips this circuit-breaker in any case of trouble that would draw more than a predetermined amount of energy from the direct-current bus-bars.

The oil switches on each individual rotary converter outfit, and those used for tie switches, are all equipped with overload attachments, which are so adjusted that they will open only in case of serious trouble. The tie switches should also be equipped with interlocking devices, so that these tie switches between lines can be closed only when the two

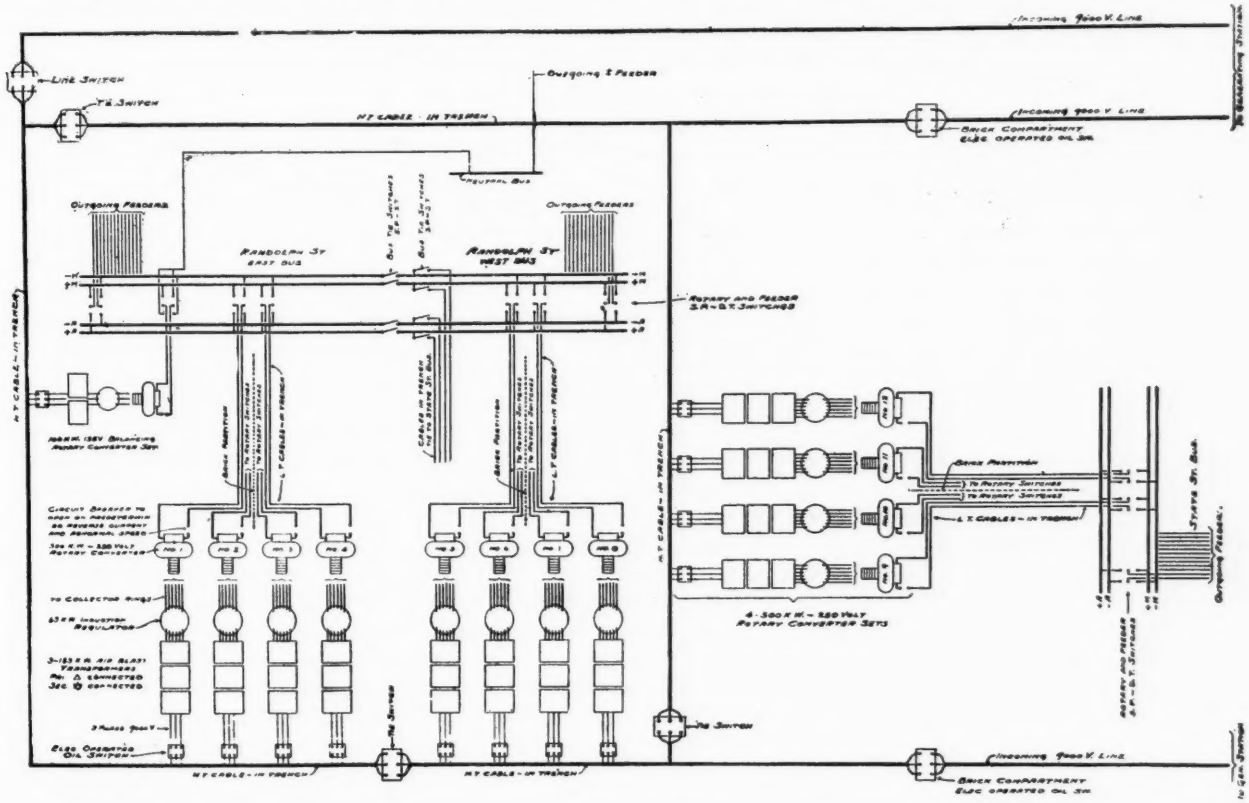


Fig. 1.—Diagram of Principal Connections in a Substation—Arranged for Independent or Multiple Control.

sources of electromotive force are in synchronism. The low-tension feeders in most of the large Edison systems are provided with heavy fuses and often with solid links. The adjustment of overload attachments on oil switches must, therefore, also be made for heavy loads and with due consideration for the particular conditions involved in each individual case.

Transmission Systems—In most of the larger cities the twenty-five-cycle transmission systems are operated at voltages varying from 6,600 to 13,000 volts. Much higher voltages have been successfully used on through trunk lines, in several other cities. This, however, is obviously a very different condition. The large transmission systems, with their multiplicity of lines, cable terminals and oil-switch connections, have grown into networks that are continually becoming more complex. As each and every case of serious trouble anywhere on a system having almost exclusively synchronous apparatus necessarily affects every part of the system, the possible chances for trouble affecting any one of the thousands of customers, are also continually increasing. Commercially, this is a very serious matter indeed, especially when we consider that with many of the more desirable customers the greatest possible security for continuous service is of first importance.

Realizing this fact, many central station engineers have taken extraordinary pains with high-tension cable work, and in some cases have succeeded in making the transmission network in itself one of the most reliable parts of the central station system, except in so far that inherently this high-tension network with its synchronous apparatus is lacking in elasticity.

This has been the experience in Chicago, where a 2,250-volt, twenty-five-cycle transmission line supplying rotary converters, was first put into service about six years ago. Since then the transmission voltage has twice been doubled. The first line, three and one-half miles long, supplied one substation having 200-kilowatt capacity in rotary converters. The resulting high-tension system, shown in Fig. 2, will, by next fall, aggregate about sixty miles, supplying nineteen substations with approximately 24,000 kilowatts installed in rotary converters and 4,000 kilowatts in frequency-changing motor-generator sets.

About twelve months ago the potential was raised to 9,000 volts. The previous and subsequent experience indicated many desirable improvements. Until this time the system was supplied only through delta-connected step-up transformers from double-current generators.

The capacity effect of lines was found to be such that in event of slight ground on one phase, it might result in an excessive rise of potential and very severe strain, if not an actual breakdown, on some part of system. The grounding of neutral on this high-tension system has been attended thus far with very satisfactory results. As star-wound 9,000-volt alternators were installed, the common point of winding was in each case connected to ground. Practically all high-tension transmission cable installed during the past two years consists of No. 4/00 three-conductor paper and lead-covered cable. The thickness of paper wall on each conductor is six-thirty-seconds of an inch, over all is four-thirty-seconds of an inch and lead wall is one-eighth of an inch.

The arrangement and installation of terminal appliances is obviously of great importance. All forms of fuses and air-break switches have been abandoned, so that at present the main circuits are made and broken only under oil. Various forms and methods of making up joints and cable-heads were tried. These are now made up in parts, so that the lead sleeve or cylindrical part of head is put in place after the individual joints have been made and insulated with paper tape. The sleeve or cable head is then filled with a special compound, which is a non-absorbent of moisture and has a much higher dielectric strength than the paraffin which was formerly used. The process of filling is such that every minute particle of moisture is expelled.

The selection of routes for transmission cable is made with a view to provide two or more lines on different streets if possible, at least in different groups of conduit for each substation. The cables are isolated and mechanically protected, so that the spreading of a bad "burnout" in either high or low-tension cables will be prevented as much as possible. A well-designed and constructed conduit and manhole system is therefore essential. Overhead connections to an extensive high-tension underground network are a source of trouble to be avoided, if possible. When unavoidable, these overhead taps should be isolated by means of transformers.

Generator, Prime Mover and Auxiliaries—The necessity for operating all units in multiple for long-hour periods in order to obtain good station economy, still exists to a very large degree. During the past ten years the sizes of units in the largest stations have been increased from 800 and 1,500 kilowatts to 3,500 and 5,000 kilowatts. The number of units however in any one station has often been decreased, making multiple operation of at least a large portion of plant more necessary than before, and also placing much greater dependence on any one unit. Such stations have been and are still passing through a critical transition period. Every case of serious trouble on generator, engine or auxiliaries affects the entire system; but it frequently happens that the system can not be sectionalized even into two parts without serious sacrifice in engine economy. The gradual increase in number of units will only partially relieve this situation.

The engine-driven unit is ordinarily one of the most uncertain elements in the central station system. Duplicate units are often installed and operated side by side under apparently the same conditions, and one, for a time at least, will prove much more reliable than the other. There is so much fitting, so many fine adjustments and valve settings, all of which must be done with great care, precision and patience. Much depends also on the faithfulness and the skill of the men in immediate charge of the apparatus. This is true of any similar apparatus, but particularly of the large engine-driven units operating in multiple on transmission systems.

With an arrangement of bus-bars, high-tension lines and substation apparatus similar to that shown in Fig. 3, generating units can be operated independently, and a certain amount of shifting of load can be done at the larger substations having four or more units in service. Rotaries can be shut down one at a time, transferred to another generating unit or another station and again put on load. During peak hours there would be shifting which would introduce some additional chances of trouble due to possible mistakes of men handling apparatus, which, in that case, would partly offset some of the advantages of sectionalizing.

In this respect, a very decided advance would be the use of a prime mover giving practically a straight line economy, such as the steam turbine. The differences between one-half load and full-load performance for short-hour periods will not be great enough to warrant much shifting. The auxiliary apparatus, particularly the condensing plant, is frequently a cause of trouble. The "sticking" of pumps, "dropping" of vacuum, and simi-

lar reports, are heard occasionally in every steam plant. The arrangement should be such that the condensing plant and auxiliary apparatus and the excitation of any one unit are simple and positive in operation and normally independent of every other unit.

Steam Supply—Practically every steam plant has its own peculiarities in piping and arrangements of boilers, but in most cases all boilers are in one room. The bursting of a steam pipe or boiler tube fills the entire room with steam instantly, making it impossible to close a valve in the ordinary way. The location of boilers in two or three different rooms or floors and the providing of means for closing valves from inside of engine room has lessened the danger of a shutdown. The placing in separate rooms, as far as circumstances will permit, of the boilers and piping corresponding to each generating unit and connecting only through fairly quick-acting remotely controlled valves will further lessen this danger.

With careful operation, customers' troubles (bad or interrupted service) that are chargeable to the boiler room are few, while those of the central station manager are many. Investigations, experiments and some improvements have been made from year to year, but the buying and economical handling of coal and making of steam still involve problems that are worthy of the very best attention, both as to the cost of operation and reliability of service rendered. These problems are especially important when we consider large stations which consume 2,500 or 3,000 tons daily, and the many possible chances of delay and interruption between the coal mine and the boiler room.

GENERAL CONSIDERATIONS.

A survey of the various classes of trouble between coal pile and customers' service indicates at once the unfortunate feature of large modern transmission systems. True, as has been done in some cases, induction motor-generators might be used instead of rotary converters. The substation apparatus would then be much less sensitive to sudden fluctuations in engine speed, or to line disturbances due to short-circuit on some other part of the system.

The first cost of motor-generators of 500-kilowatt and 1,000-kilowatt capacity installed complete is, however, from fifteen to twenty-five per cent greater than for rotary converters with accessories. Under ordinary operating conditions there is a difference of from three to five per cent in efficiency in favor of rotary converters. The power-factor of the rotary converter is obviously much better than that of the induction motor. The characteristics of a rotary converter are often a practical advantage in cases of trouble on low-tension feeders or mains.

In some few cases where it is necessary to run a large number of converting units from a long transmission line which itself is subject to heavy fluctuations in potential and frequent interruptions, it may be advisable to use motor-generator sets. In the large majority of cases, however, in both lighting and railway work, the rotary converter has been found the best and most economical. If the objectionable features thus introduced can not be overcome, the result can at least be mini-

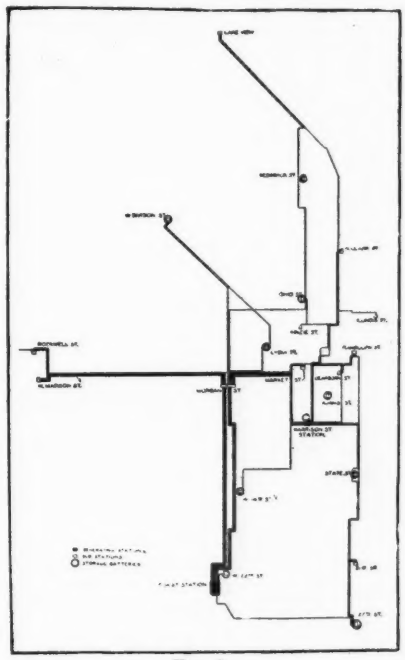


FIG. 2.

mized by judicious sectionalizing in large systems.

The electrostatic capacity of these large high-tension cable systems is such that there is necessarily a practical limit to the mileage of cable that can safely be operated as an interconnected network. In the sixty miles of 9,000-volt, three-phase, twenty-five-cycle lines previously mentioned the charging current as calculated will be about sixteen amperes. At the present rate of increase in mileage the condenser effects will soon be troublesome and possibly prohibitive, as trouble may occur which will result in building up a potential at some point and breaking down insulation on apparatus that was comparatively safe on the smaller system. In that event, and with several very large units all in multiple, the amount of power delivered on short-circuit would probably be so great that it could not safely be interrupted by any oil switch thus far built.

In a rapidly growing system provision for a reasonable amount of sectionalizing can easily be made. The investment in the portion of central station system between coal pile and customers' service most directly involved, is, under most conditions, divided approximately as follows:

Station—real estate, building and generating apparatus, thirty-five to forty-five per cent.

Transmission system—cables and conduits, three to six per cent.

Substation—real estate, building and converting apparatus, ten to fifteen per cent.

Feeders and mains—cables, conduits and Edison tube, forty to forty-eight per cent.

These percentages are greatly influenced by local conditions, such as average and maximum density of load, value per duct foot of underground conduit, average length and voltage of transmission, cost of real estate and character of buildings. In railway plants, the investment in substations and that corresponding to feeders and mains will be less, while the investment in transmission lines will be somewhat greater. A considerable capacity in storage batteries will, under load conditions obtaining in most large systems, decrease slightly the investment in the first three, but would not affect that in feeders and mains.

The provision for sectionalizing will not increase the investment or operating costs, either in substations or in feeders and mains. In the transmission system it may, under some conditions, slightly increase the total mileage of lines; but such an increase in the three to six per cent thus involved is a very small increase in the total investment in entire system.

A review of power-houses indicates that there is a wide difference in cost of station buildings. This difference is a matter partly of engineering and partly of management. Taking the total cubical contents of six of the large modern station buildings, we find that from six to ten per cent is devoted to coal storage and that the complete buildings vary from 100 to 240 cubic feet, and from 0.95 to 2.5 square feet per kilowatt rated generating capacity. The boiler room portion of the same stations vary in total net cubical contents from 65 to 130 cubic feet per rated boiler horse-power, while the engine room portions vary from forty to ninety cubic feet per rated engine horse-

power. As practically the same types of boilers are used, the former depends almost entirely upon the design and arrangement; but the latter depends largely upon the type of generating unit adopted. In the case of vertical turbine-driven units, the figure for this portion of plant can be reduced by at least one-half.

The tendency, however, in power-house design is toward a much more liberal allowance for space for all equipment. The high-voltage generators of large capacity

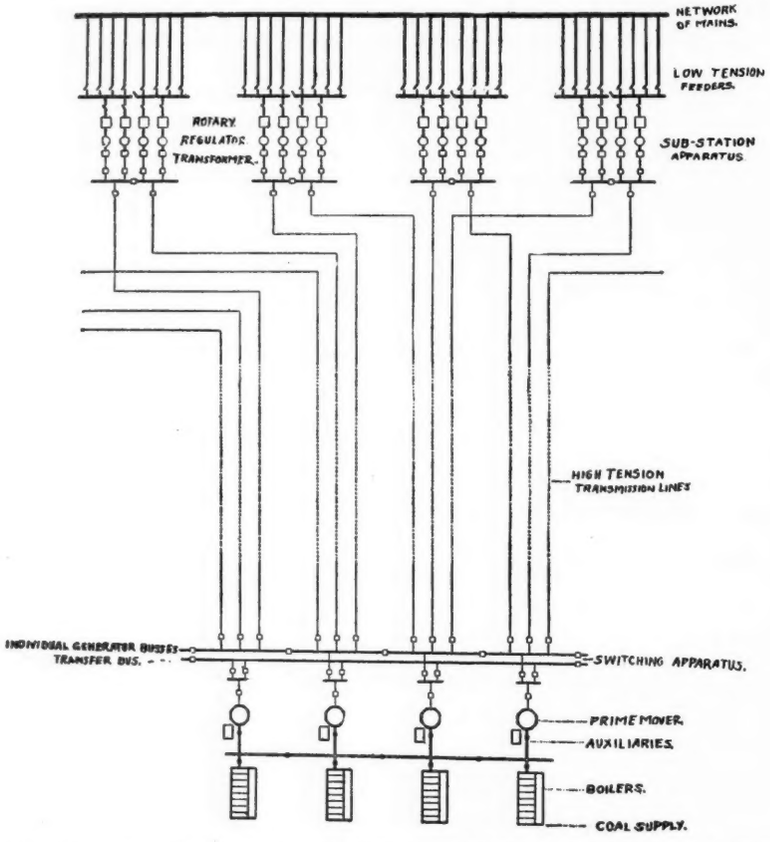


FIG. 3.—DIAGRAM OF CONNECTIONS FOR STATIONS, SUBSTATIONS AND TRANSMISSION SYSTEM, ARRANGED FOR INDEPENDENT OR MULTIPLE OPERATION OF UNITS.

and multiplicity of lines demand extraordinary switching apparatus which requires considerable space. A suitable arrangement and reasonable isolation of switching apparatus and connections need not require any additional space and should preferably be much simpler than that in many existing stations.

It would seem, therefore, that in the large modern power-house sectionalizing and even entirely independent operation of units can be provided for with very little, if any, additional investment in the generating station or in any other part of the system.

While the independent operation of generating units would tend to minimize the effect on customers of many central station troubles and thus increase the coefficient of reliability, there will also be some disadvantages. A heavy overload or perhaps short-circuit coming entirely on one unit or group of lines might trip the oil circuit-breaking switches on lines, and the sudden release from load severely strain the prime mover. This cause would be improbable if, as indicated in Fig. 3, each generating unit supplies at least two different substations and when only part of the load would be thus released on any one generating unit.

If a short-circuit occurs on a feeder supplied by a small group of rotaries, the percentage of overload is larger and after one rotary trips, the others will immediately follow. This might not have occurred with a larger group, when the percentage of overload would have been correspondingly less. All transmission lines should be equipped so that oil circuit-breakers at both ends of line open automatically in case of trouble, whether the entire system is operated in multiple or independently.

In the latter event, if time limit attachments are used with overload devices at the station, the amount of energy delivered at the point of breakdown might not only slow down the engine but draw enough energy from network to trip the circuit-breakers on all rotaries supplied from the particular generating unit. If operated as shown in Fig. 3, this would mean under full conditions, an overload of fifty per cent on the remaining rotaries in each substation supplied from three different generating units; 100 per cent overload on those supplied from two, and a total shutdown of such small substations as are supplied exclusively from the particular unit in trouble. Usual result: low pressure on part of direct-current system; no trouble elsewhere.

In event of multiple operation of the entire system, with several units in service, a large amount of energy from the station bus-bars would be delivered until time limit overload devices at the station and reverse current devices at the substation cut out the troublesome line. Usual result: heavy fluctuations in pressure on entire system, until line is opened at both ends, several machines shut down and sometimes a total shutdown.

During the hours of light load the system would naturally be divided into fewer parts or perhaps all in multiple. In event of a shutdown during these hours, the capacity of storage batteries would be so much greater in proportion to load that the drop in pressure would not be so serious.

The successful operation of large systems necessitates the maintaining of a well organized operating force of competent and experienced men. Every operation involving the starting or shutting down of a generator, line or substation unit should be carefully regulated and checked to reduce to a minimum the possibility of a mistake. In one of the large stations now under construction provision is made for a load despatcher, whose office will be convenient to the operating switchboard and who can control absolutely the transferring of load between all generating, transmitting and converting units, with the same implicit confidence and accuracy of judgment and action as can the train despatcher on an important railroad system. His office should be a clearing-house for all orders concerning operation of system.

After considering some of the advantages and disadvantages of multiple and independent operation in large underground transmission systems, it might be of interest to consider small overhead systems. The latter are operated independently, in very many cases with satisfactory results as to reliability of service rendered. In order to secure more economical engine performance, it was necessary to adopt large units operating in multiple. This step also improved the reliability of service

rendered, particularly where each feeder emanating from the bus-bars continued to supply its own independent system. If these small systems of taps, radiating from a centre of distribution at feeder ends, had been arranged into one interconnected overhead network covering a large area, the coefficient of reliability with the same character of construction would undoubtedly have been decreased. These systems, usually supplying current for induction motors and for lighting, are fairly elastic; but on account of the higher potential, usually 2,000 volts or more, a short-circuit obviously affects a very large area and often the entire system. The matter of regulation being comparatively easy, there is, therefore, a distinct advantage in operating independently the different feeders instead of on an interconnected network. With an overhead system exposed to the elements and so many chances of interference from an exterior source, a modern station is usually the more reliable part of a system, and therefore there is little necessity of sectionalizing the station. As a precautionary measure, however, and to facilitate future extensions and repairs, stations should be designed so that this can be done.

In conclusion, it might be said that considering responsibility for the business and return on investment, every central station system should be designed, if not for independent, at least for sectional operation. In the very large stations, the independent units from coal pile to distributing network, or to rails, should be effectively isolated to make a total shutdown practically impossible. The matter of independent, sectional or multiple operation at different hours of the day or days of the year is entirely one of local conditions, which may change frequently. Great care and constant attention are needed to maintain a fairly uniform and consistent coefficient of reliability on every part of the central station system. Independent and even sectional operation will mean a small sacrifice in operating cost. With a system properly designed, this matter, then, becomes to the central station management a plain business consideration; to take the risk of inferior service and possible shutdown, or to pay a premium in the form of very slight sacrifice in operating costs and thus obtain an additional safeguard for superior service to all or such groups of customers as business requirements may demand.

Subjects of Theses in Electrical Engineering at Lehigh University.

The following are the subjects of theses which are to be presented by the students in electrical engineering at Lehigh University:

"An Investigation of the Thermal Conductivity of Various Steam Pipe Coverings by an Electrical Method and a Discussion of Its Bearings on Central Station Economy." By J. J. Cort.

"Experimental Study of the Variation of the Stray Power Losses in Direct-Current Dynamo Machines." By S. W. Goldschmidt and G. M. Kennedy.

"Experimental Study of an Open-Coil Arc Lighting Dynamo." By C. F. Hinckle, Jr., and G. J. Walz.

"Experimental Study of a 7.5 Horse-Power Induction Motor." By. R. Hunt and C. B. Graham.

"Experimental Study of the Instantaneous Contact Method of Measuring Alternating Electromotive Force and Current." By C. E. Marks and C. L. H. Ruggles.

"Experimental Study of Liquid Rheostats." By N. B. Robbinovitz.

"Tests on Alternate-Current Transformers." By R. N. Skillman and N. A. Wolcott.

The Puyallup River Power Scheme.

Messrs. Stone & Webster, of Boston, Mass., are preparing for the installation of a large power plant in the state of Washington to utilize the glacial flow of Mount Rainier for the development of electric power for the Puget Sound region. Six 3,500-kilowatt generators have been ordered from the General Electric Company for this installation, which will contain the largest units in operation west of the Rocky Mountains.

The glacial flow of the Puyallup River will be utilized to develop 20,000 horsepower, which will be transmitted at high tension to Seattle and Tacoma for the various lighting and railway companies controlled by this management, including the interurban railway between the two Puget Sound cities. Electric power will also be furnished at wholesale for general manufacturing purposes. The Puyallup River will be dammed at a height of 1,700 feet and the water diverted through a flume and ditch ten miles long to a point near Lake Kapowsin, where the power station will be located. At the end of the ditch line a forebay is being constructed from which four steel pipes, tapering from a diameter of four feet to a five-inch nozzle, will deliver the water to tangential wheels under a net head of 850 feet.

The delivery of machinery for this plant will begin in September, and it is planned to commence operation before the end of the year. The power will be generated at 2,300 volts, alternating, "stepped up" to 50,000 to 55,000 volts, and transmitted to Tacoma, about thirty miles, and to Seattle, which is about forty-five miles distant. The pipes which deliver the glacial flow to the water-wheels will be anchored to the hillside by concrete anchors, for which purpose a clearing has already been made.

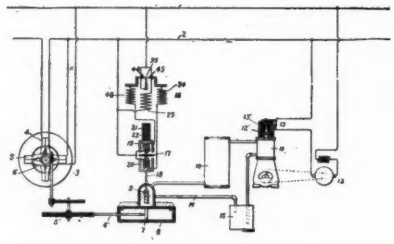
Mount Rainier is a peak of volcanic origin, which rises 14,519 feet above sea level and has an ice cap over 100 square miles in extent and varying in thickness from 100 to 1,500 feet. Seven great glaciers are drained by the Puyallup and White rivers, furnishing a never-failing supply of water. The glacial flow never ceases, although it is lowest during the rainy season, when the natural drainage of these rivers supplies all the water that they can carry. During the dry season, when no rain falls, the glacial flow is at its height. Furthermore, these glacial streams show a daily rise and fall corresponding to the daily change in temperature. The glacial tide, as it is called, commences to rise toward noon, when the sun is hottest, and does not begin to drop until toward five o'clock. Owing to the time it takes the water to flow from the glaciers to the power-house, the tide is manifest there from five o'clock in the afternoon to eleven at night, or the time during which the use of street cars and electric lights brings the heaviest load upon the plant. The water supply is further protected by the fact that the greater portion of Mount Rainier is included in the United States Forest Reserve.

Arrangement for Operating Arc Lamp Circuits.

Occasionally it is desirable in factory or yard arc lighting to be able to cut out certain of the lights at will. Mr. Fritz Suchting, in a recent issue of the *Elektrotechnischer Anzeiger,* gives a description of a neat way of accomplishing this. In the case assumed, there are four lamps to be operated from a 220-volt circuit. These are to be operated either in pairs or simultaneously, and the switching can be done by means of one double-pole double-throw switch and a single-pole double-throw switch. When operating all the lamps a certain amount of dead resistance is necessary. This can be cut in on either side of the circuit. When operating with two lamps, additional resistance must be added, which is placed in the third wire, running to some point between the two pairs of lamps. With all the resistance placed beyond the knife switches, the most economical arrangement is found to be with 3.1 ohms in the outside wires, and 12.3 ohms in the middle wire. The conditions assumed are nine-ampere lamps, each taking forty-one volts. Since, however, with either pair of lamps in operation, part of the resistance is idle, a more economical arrangement consists in placing a portion of the resistance beyond the switches, so that it is always in circuit. This should be equal to the amount of the two resistances connected in the outside wires, and is therefore 6.2 ohms. But, by virtue of its position, the amount of resistance in the central wire is reduced to 9.2 ohms.

Electrical Patents.

The General Electric Company has purchased a patent just issued to Mr. James B. Foote, of Jackson, Mich., on an improved electric regulator designed to secure a regulating action which shall be checked as soon as the proper regulating effect has been secured and not be permitted to pass through a series of oscillations of decreasing amplitude about the desired point. The invention can be readily understood by reference to the accompanying diagrammatic view, wherein the conductors forming part of an electric distribution or transmission system are designated by the numerals 1 and 2. The immediate means for controlling the voltage of this system may be of widely different character. Thus, for example, the field strength of the generator may be varied, or the speed of the generator may be changed. In the present instance, however, the inventor prefers to employ a potential regulator of well-known construction. A winding 4 on this regulator is in series with one of the mains—as, for example, the main 2—while a second winding 5, located in this instance at right angles to the winding 4, is connected in shunt to the mains 1 and 2. A flattened body 6 of magnetic material is located within these coils or windings and is mounted on bearings, so that it may be rotated. By changing the angular position of this body the mutual induction between the series and the potential coils may be varied, thereby causing the potential coil to exert a correspondingly varied boosting effect upon the series coil, this boosting effect acting to regulate the voltage of the lines 1 and 2 as desired. For the purpose of mechanically actuating the regulator 3, the rotating member thereof is connected through gearing 5′ of any suitable construction to the piston-rod 6′, extending from a piston 7, to which motion is communicated by fluid-pressure derived from any suitable source. The piston 7 of the actuating device is movable within a cylinder 8, to which some suitable fluid, as oil, may be admitted through the operation of a controlling valve—such, for example, as 9. The oil may be contained in a tank 10, in which it is maintained under pressure by means of some suitable pump. In the present instances, by way of illustration, a pump has been indicated, driven by an electric motor 12, the circuit of which is controlled automatically by a switch 13, which through the action of the fluid-pressure is caused to close when the pressure is too low and to open when the pressure is too high; the opening and closing of the switch being governed by a piston 12′, operated upon by the fluid-pressure and acting in opposition to a properly adjusted spring 13′. The oil after it has been admitted to the cylinder 8 and has moved the piston thereof in either direction is then discharged through the exhaust pipe 14 into a receiving tank 15, from which it is drawn by the pump 11 and again forced into the tank 10. The valve 9, which controls the fluid actuating device, is in turn actuated magnetically through the operation of a controlling device (indicated in diagram at 16). The magnetic actuating means consist of an armature 17, carried by a rod 18 and mounted in proximity to a pair of magnets 19 and 20, the circuits of which are opened and closed by the controlling device 16. Centering springs 21 and 22, acting on the valve stem 18, serve to maintain the valve 9 in its closed or intermediate position. When one of the magnets is energized, the valve 9 will be moved in one direction, thereby causing

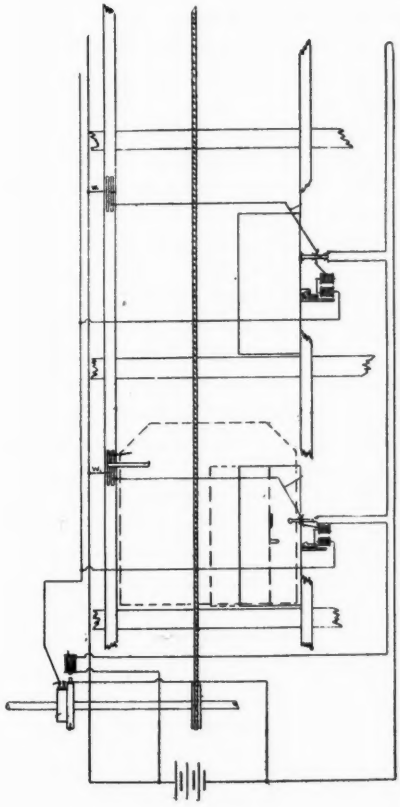


NEW ELECTRIC REGULATOR.

a corresponding movement of the piston 7, while when the other magnet is energized an opposite resulting motion of the piston 7 will take place. The controlling device 16 consists of a main contact controlled by the quantity to be regulated and cooperating contacts acting in conjunction therewith to close the circuit of either of the magnets 19 and 20. These cooperating contacts are arranged so as to retreat or be withdrawn momentarily upon each engagement between the same and the main contact under control of the quantity to be regulated, which in this case is the potential upon the mains 1 and 2. The controlling device 16 includes a swinging main contact 35, the position of which is determined by the magnitude of the quantity to be regulated, and cooperating with this main contact is a pair of movable and vibratory contacts 44 and 45, each of which is mounted upon a pivoted carrier. These retreating contacts are actuated by suitable magnets 54. The operation of the regulator is substantially as follows: When the potential varies from normal, the main contact 35 is shifted either to the right or the left, as the case may be and engages one of the retreating contacts 44, 45. Supposing, for example, the main contact 35 is moved to the right and engages the retreating contact 45, immediately upon this engagement a circuit is closed from the main 1, through the magnet 54, through the magnet 20, and back to the main 2. The valve 9 then commences to open under the action of the magnet 20, while at the same time the retreating contact 45 moves backward through the energizing of the magnet 54. The retreating contact thereby acts to open the circuit, which it has previously helped to close and through the resulting deenergizing of its controlling magnet 54 is immediately allowed to return toward its normal position, thereby again coming in contact with the main contact 35, whereupon the retreating action is repeated, the series of resulting advances and retreats of the retreating contacts constituting a continued oscillation or vibration which serves to transmit to the valve 9 of the mechanical controlling device a sort of series of taps, as it were, which allows a just sufficient regulating effect to take place and checks this regulating effect as soon as it has attained the proper amount. Without this series of impulses it would be necessary for the regulating effect to overstep slightly the amount required to bring the mains back to normal potential before the main contact would return, thereby necessitating a reversal of the regulating action, which is apt to continue through a series of oscillations before the final regulation is secured. The arrangement shown is particularly effective in preventing this objectionable seesawing effect, and this is due to the fact that as the regulating action proceeds the main contact moves back toward its normal position, thereby increasing the amplitude of movement of the cooperating contact, the oscillations of which thereby become longer and longer and finally cease when the desired regulating effect has been secured.

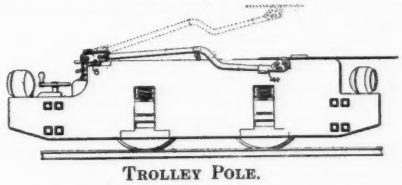
A safety apparatus for elevators has recently been patented by Mr. Edward H. Price, of Sioux City, Iowa. The invention relates to devices in which the elevator door can not be opened until the elevator car or cage is opposite one of the floors of the building, and when once a door is opened, the car can not be started until it is again closed. For this purpose a lock is employed on the shipper shaft. This lock comprises a cam secured to the shaft and having a notch in its periphery. An electromagnet is mounted contiguous

to the cam and the movable armature of the same is in the form of a latch that drops into the notch of the cam when the magnet is unexcited. The coils of this magnet are in a circuit which is always open and comprises contiguous strips arranged upon one of the guide posts of the elevator, these strips being engaged by suitable brushes carried by the car and arranged to connect electrically the strips. The circuit is open except when the doors are shut, and for this purpose each door is provided with a circuit closer suitably connected with the conductors. In order



to prevent the doors from being opened except when the car is in line with the different floors, each door is provided with a locking device controlled by a separate circuit, and these circuits are only closed when the car is in such position that the brushes connect the same so as to permit the opening of the door. Therefore, assuming all the doors closed, the latch circuit will also be closed, the latch being thus elevated so that the shipper shaft is free to be operated and the elevator started in either direction. When any floor is reached the brushes on the cage come into proper position to close the circuit of the door, but such circuit can not be completed until the shipper shaft is in proper position to be locked. When, therefore, the elevator car is at a standstill opposite one of the floors of the building the doors may be opened freely. Immediately upon such opening the circuit through the lower magnet is broken, releasing the pawl or latch, and locking the shaft against movement. This circuit remains broken until the door is closed, so that the elevator can not be started as long as the door is open. Simultaneously with the breaking of the magnet circuit, the lock circuit is broken, but as soon as the door is closed again the circuits are reestablished to start the elevator and as soon as the car moves the lock circuit is broken again, so that all the doors are again held against being unlocked until the car is stopped opposite another floor.

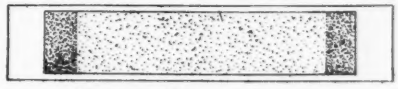
Messrs. Charles A. Bray and Florien C. Fry, of Schenectady, N. Y., have patented a trolley pole and have assigned their entire interests therein to the General Electric Company. The pole is intended more particularly for use on mining locomotives, which traverse contracted passages. The main tunnels of a mine are frequently very narrow or of



TROLLEY POLE.

considerable depth, while other passages may be shallow and broad. This is especially true of coal mines where the chambers are of a depth equal to the thickness of the seams. The object of the invention is the construction of a pole which will adjust itself to connect either with a conductor above the vehicle carrying the pole, or at one side of the same and at a level with or below the top of such vehicle. The pole is revolubly mounted on the locomotive in the usual manner and is made up of sections. The first section is preferably constructed of wood and is clamped in a socket pivoted to the trolley base. The second section is of metal tubing and has a straight portion receiving the end of the pivoted section. Another portion of this section, which is substantially parallel to the inner portion, is connected thereto by an intermediate angular offset. At the outer end of the pole is secured the trolley-wheel holder or bracket, which may be of the ordinary construction or swiveled on the pole. A pole as thus constructed will engage the conductor above the locomotive in the ordinary manner, or will assume a position at one side of the vehicle and at a level with or lower than the top of the same.

A German, Johann Friedrich Boelling, of Frankfort-Bockenheim-on-the-Main, Germany, has patented in this country an electrical resistance device or heater. This patent has been purchased by the Prometheus Electric Company, of New York, N. Y. The new resistance device or heater substantially consists of a strip of mica having on its surface a layer forming the electrical resistance and a layer of suitable insulating material covering the resistance layer on the strip of mica and



ELECTRIC HEATING DEVICE.

metal strips which with their ends are pressed against the resistance layer by the insulating cover and which form the terminals of the electric circuit. A cover of sheet metal may be provided on one or both sides of the strip. The sheet-metal cover, which rests on the insulating layer, is provided with cut openings which allow the metal strips forming the terminals of the electric current to hold out of contact with the sheet-metal cover. The resistance layer may be fixed on the strip of mica by applying a coating of a thin solution of metal to the mica and then heating the strip of mica to dry out the solvent. Resistance strips of this kind are able to sustain high temperatures and are very durable when the mica is pressed against another surface. However, it is to be taken into consideration that strips of mica which are suitable for the purpose of fixing a resistance layer on same generally are not longer than 200 millimetres.

The American Electrotherapeutic Association.

The next annual meeting of the American Electrotherapeutic Association will be held at Atlantic City, N. J., on Tuesday, Wednesday and Thursday, September 22, 23 and 24, 1903. Many persons prominent in electrical engineering are members of the association, and the combined efforts of the electrician and the physician have enabled the society to do much good work. A booklet has just been issued which lists the officers and the special committees, and affords a biographical sketch of the association. In addition to this is the constitution, as well as the by-laws, and a list of the fellows, honorary fellows and associate fellows.

Reviews of Current Engineering and Scientific Literature.

Dynamo and Motors on Vertical Axles, Turbines and Centrifugal Pumps.

In many water-power installations it is desirable to install a turbine with a vertical shaft and in these cases it is desirable to use a vertical dynamo rather than a horizontal one driven through bevel gears. In this article the requisites for dynamos of this type are discussed and details given of suitable bearings and other parts. If the machine is small, ball-bearings may be used and thus reduce the friction. For motors a step bearing is suitable, but for generators the armature must be suspended from the upper end of the shaft and a suitable bearing is shown. For large machines, thrust or collar bearings are most satisfactory. The best design for these is a cone-shaped collar with the flat face below. This journal is placed in a similar bearing lined with anti-friction metal and with a cooling chamber through which water is circulated. Oil is pumped to the upper bearing from above and runs out and down into the lower bearings which guide the shaft. Other details of the vertical machines differ but little from the horizontal machines except the method of supporters. Suitable types of sub-base are illustrated as well as spiders for supporting the thrust bearing.—*Translated and abstracted from L'Industrie Electrique* (*Paris*), *April* 10.

Liquid Fuel for Power Purposes.

The increasing cost of coal and the discovery of new oil fields have made the question of the use of oil for fuel a vital one. In this article, Mr. A. L. Williston discusses the requirements for successful use of oil and describes several types of burners which have given good results. In the first attempts to use oil as a fuel, it was introduced into the furnace in bulk, without air or steam and without any attempt to atomize it. This method made it impossible to force the fire, and this use of oil was not successful. This failure brought about the use of burners, by which the oil is sprayed into the furnace. Burners of this type may use either steam or compressed air or both. In some of the most successful burners a jet of steam is used to atomize the oil, and an air inlet in the burner allows the oil to be mixed with air at the same time. Burners using steam are simple and the heating of the steam makes the oil more fluid and thus assists atomizing. At the recent navy tests, it was found that less steam was required if used directly to atomize oil, than when used to compress air. However, the most economical results were obtained, so far as consumption of oil is concerned, by the use of air at low pressure at from one to two pounds per square inch. When steam is used directly less than two per cent of all of the steam generated in the boilers is necessary for atomizing oil, while with compressed air about four per cent of the steam is used. The best results seem to be obtained by use of jets of steam which atomize the oil. The burner should have air in it and the furnace should be so compressed that air can be dampered at various points in the furnace. Suitable dampers allow the firemen to regulate the supply of air so that complete combustion without an excess of air is obtained. Suitable types of furnaces are shown and the proper designing and construction of these are discussed.—*Abstracted from the Engineering Magazine* (*New York,*) *May.*

The Transmission Line and Terminal Station of the Shawinigan Water and Power Company.

The transmission system of the Shawinigan Water and Power Company has recently been put in operation. Current is transmitted from the Shawinigan Falls to Montreal, a distance of almost eighty-five miles, at a pressure of 50,000 volts. The source of supply is the Shawinigan Falls, on the St. Lawrence River. A canal 850 feet long, 100 feet wide, and forty feet deep diverts a volume of water sufficient to produce 75,000 horse-power. The line consists of cedar poles ten inches in diameter at the base, and seven inches at the top, with a minimum length of thirty-five feet, the poles being set six feet in the earth, and 100 feet apart. The cross-arms are of four and three-quarter square inch Georgia pine, and are six feet in length, treated with liquid asphalt. The pins are two and one-half inches in diameter and eighteen inches long, and the insulators are white porcelain, each weighing fifteen pounds. They have been tested to over 100,000 volts. Each of the three transmission cables is composed of seven strands of No. 6 B. & S. gauge aluminum wire. The total weight of wire in the entire line is 250,000 pounds. The two lower cables throughout the transmission line run at an approximate height of twenty-six feet from the ground. The ends of each length of cable are joined by McIntyre sleeves by slipping the ends of the cables inside the oval tube, which is one-half inch by one inch, and nine inches long. The tube is then twisted, thus firmly binding together the two lengths of cable. It is intended to cross the Ottawa River on the railway bridge, as soon as it is completed. The line now crosses the river by two spans of three one-inch steel cables supported on four towers, each ninety feet high, placed on the banks and on an island in the river. The cables are supported on the tops of the towers by means of porcelain insulators. As the Shawinigan company could not enter Montreal, it delivers power to the Montreal Heat, Light and Power Company, which distributes it. At this station the current is transformed down to 2,200 volts, and then used to drive frequency changers and motor-generator sets. Two frequency changers, each of 800 kilowatts, have been installed, and two more are now being erected. These machines are started by means of a small motor-generator set and the exciter which is mounted on the end of the shaft.—*Abstracted from the Canadian Electrical News* (*Toronto*), *April.*

The Solidification of Fluorine and the Combination of Solid Fluorine with Liquid Hydrogen.

Extended work has been carried on by Drs. H. Moissan and J. Dewar with fluorine at low temperatures. This gas has been liquefied at minus 187 degrees centigrade, and at this low temperature it acts neither upon crystallized silicon, amorphous carbon, boron nor mercury. Its chemical activity is diminished, but it still combines with production of flame with hydrogen and solid turpentine. Carrying these researches further, liquid hydrogen has been obtained at minus 252.5 degrees, or at 20.5 degrees absolute. It has been shown that fluorine which is perfectly free from hydrofluoric acid does not attack glass at ordinary temperatures. Hence, it was possible to enclose a definite volume of fluorine in a thin sealed glass

vessel, and submit it to the powerful cooling action furnished by the ebullition of liquid hydrogen. A sealed tube filled with fluorine, and placed in liquid oxygen, boiling quietly under an atmospheric pressure, showed no trace of condensation. The same tube was lowered slowly into a double-sealed vessel containing liquid hydrogen. A yellow liquid appeared, which froze to a yellow solid, finally becoming white. Experiments with liquid nitrogen showed that the melting point of fluorine is below minus 210 degrees centigrade, and a comparison with the melting point of oxygen showed that forty degrees absolute or minus 223 degrees centigrade was the most probable value for the melting point of fluorine. The ratio of the melting point to the boiling point is a little smaller than the ratios given by chlorine and bromine. To determine whether any action is possible between liquid hydrogen and solid fluorine, a thin glass tube containing about fifty cubic centimetres of gaseous fluorine, free from hydrofluoric acid, was cooled until the gas solidified, when the point was broken off, allowing the fluorine to come in contact with the hydrogen. A violent explosion was the result, sufficient heat being set free to raise the material to incandescence and set fire to the hydrogen. All the glass vessels were shattered. Helium is now the only gas which has not been obtained in the solid state.—*Abstracted from Nature (London), March 26.*

The Butte Lighting and Power Company.

This article gives a very complete and detailed description of the Bighole power plant near Butte, Mont. The hydraulic development consists in the construction of a dam sixty feet high to obtain head for operation of turbines. The water supply for the reservoir thus obtained is supplemented by water from two storage reservoirs, located about twenty miles above the main reservoir at the plant, on the north and south forks of the Wise River. The reservoir on the north fork has an estimated capacity of one billion cubic feet, while the south fork reservoir is estimated to contain about half this amount. The combined capacity of the reservoirs holds sufficient water to supply 325 gross horse-power per day for one year. Having this amount of water in reserve, the normal stage of water in the power reservoir can be so maintained that the established minimum flow shall not fall below the quantity estimated for power purposes. The average minimum flow at the station was found from measurement taken daily from August to the following April, to be about 350 cubic feet per second. From intermittent measurements taken previously, the minimum flow was assumed to be greater than found during the time stated, and the company based its investment upon the previous measurements assuming an average minimum flow of not less than 400 cubic feet per second, assuming a seventy-five per cent working efficiency for the turbines and a loss of ten per cent in transmission, with a sixty-foot head, which is estimated, with a net minimum delivery of 1,836 horse-power, could be counted upon in Butte, and it was to maintain this output that the auxiliary reservoirs were constructed. Upon the commercial value of this power it was estimated that the project would support a capital investment of $500,000. A rock-filled crib dam was adopted. Leffel turbines with an output of 1,200 horse-power, each controlled by Lombard governors, drive four General Electric three-phase generators, delivering current at 800 volts which is raised to 23,000 volts by the transformers, of which there are twelve of 250 kilowatts capacity. Two exciters, of 100 kilowatts capacity, excite five generators. Each exciter is directly connected to a turbine running at 600 revolutions per minute. The pole line is about twenty-one miles in length, the poles of different lengths being used to maintain as much as possible uniformity of grade. Power is transmitted by six No. 1 B. & S. copper wires with an estimated loss of nine per cent at maximum load. The poles are set fifty to the mile and support three cross-arms, the upper two being ten and one-half feet in length and carrying the power wires. Transposition is made by adding a third cross-arm to its consecutive poles. At the first pole one wire drops to the lower cross-arm and the others are shifted one. The second wire drops to the lower cross-arm, the others being shifted again, and so on until one complete turn has been made. This is done every mile. There are three transmission systems supplying power to Butte, that of the Madison operating in parallel with the Bighole plant, the contract being such that the former company supplies power at 100 per cent load-factor. This is accomplished by use of separate batteries with the Bighole plant floating on the load. The substation is described, and a brief account is given of the use of power in the country around Butte.—*Abstracted from Journal of Electricity, Power and Gas (San Francisco), April.*

The Measurement of the Internal Resistance of a Battery.

Methods of measuring the internal resistance of a primary battery are troublesome and less accurate than the corresponding methods of measuring ordinary resistance. Measurements of internal resistance are particularly unreliable if made while the cell is furnishing current, as the resistance may change while the bridge is being balanced. In this article Mr. J. A. Oates describes two methods which require no apparatus beyond that found in most laboratories, and which reduce the error caused by polarization to a minimum. The first of these consists in comparing the potential difference between the poles of a given battery on an open and on a closed circuit, by means of a potentiometer, constructed by placing two post-office boxes in series, and passing through them current from two Leclanche cells. One terminal of a small adjustable resistance and one pole of the cell to be tested are joined to one terminal of this bridge. A galvanometer is connected between the boxes, and, by means of mercury cups, can be connected to the cell to be tested and to an auxiliary resistance. When no deflection is obtained on inserting this bridge, the resistance of the battery can be computed from the ratio of the potentiometer arms and the auxiliary resistance. The second method has been in use at Yorkshire College, England, for some years, and consists in equating the drop of potential between the terminals of the cell, short-circuited through a small resistance, and a known fraction of the potential difference between the terminals joined through a large resistance. This is accomplished by means of an auxiliary potential difference which is obtained from two Leclanche cells connected across an auxiliary potentiometer. The cell is arranged so that, by introducing a double U-shaped copper bridge into three mercury cups, the auxiliary resistance is balanced first against part of the potential difference between the terminals of the battery, when connected across a high resistance, and a moment later, when connected across a low resistance. A table showing results of tests made by both methods is given. These show good agreement between the values determined by different experiments when using the same method, and between values obtained by the use of the two methods.—*Abstracted from the Electrician (London), April 17.*

INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

A New Kelvin Galvanometer.

The L. E. Knott Apparatus Company, Boston, Mass., recently placed on the market an improved form of Kelvin galvanometer, for which many points of merit are claimed. This instrument has been designed with due regard to the demands of cable testing, of Wheatstone bridge and thermoelectric work. The needles are made short and light, of special magnet steel, magnetized to saturation, and then artificially aged to secure permanency. The system is astatic and dead-beat, the needles being mounted on a very light vane. For reading with telescope and scale, a small and specially light plane mirror is furnished. Where it is desired to read with a lamp and scale, instead of using the telescope, a slightly heavier system, with concave mirror, is recommended, although if a proper lens be added to the equipment, the plane mirror permits of reading with lamp and scale. If desired, an astatic ballistic needle system is supplied, with bell magnets and with a rather large concave mirror, especially suited for use with lamp and scale.

For the suspension system a comparatively short fibre of selected cocoon silk has been adopted. This special fibre, the manufacturer states, has as little torsional resistance as any, but excessively long quartz fibres.

For instruments which are intended to serve both for ballistic and dead-beat work, there is provided a special tripod suspension which allows the easy substitution of a different needle system. This is shown in Figs. 1 and 2, illustrating, respectively, the front and side elevation of the galvanometer. In making a substitution, the manipulation of the instrument is as follows: The galvanometer cover is removed, and the suspension tripod, together with the whole dead-beat needle system, is lifted out vertically and laid at length upon a table, taking all strain from the fibre. The suspension rod is withdrawn after loosening its set screw, and is left attached to the fibre of the needle system. Another suspension rod, previously attached to the fibre of the ballistic needle system, is then introduced into the tripod, fastened by the set screw, and the tripod and needle system are placed in position in the galvanometer. The tripod gives a rapid and accurate means of centering the needle system in its gap, and after having been

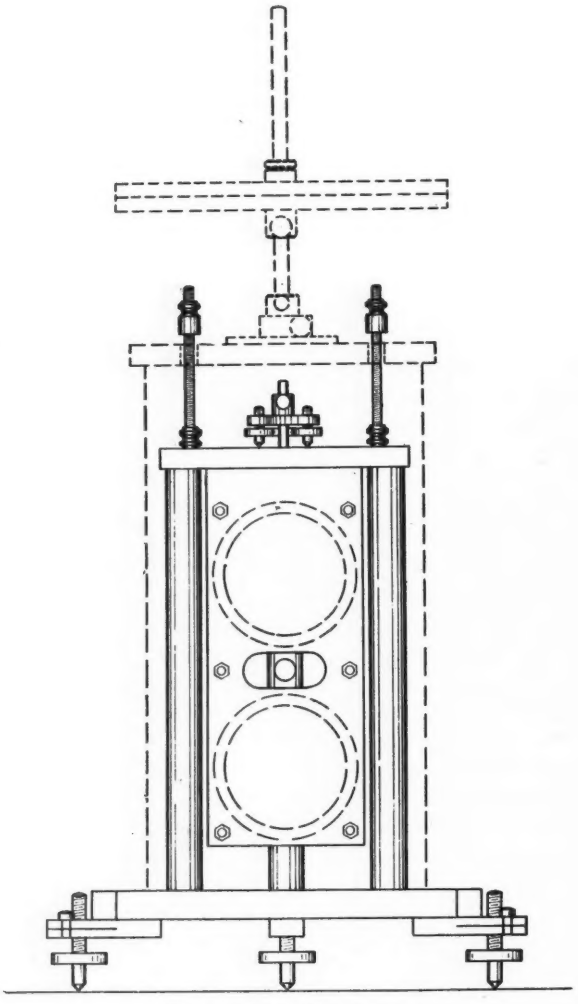


FIG. 1.—FRONT ELEVATION.

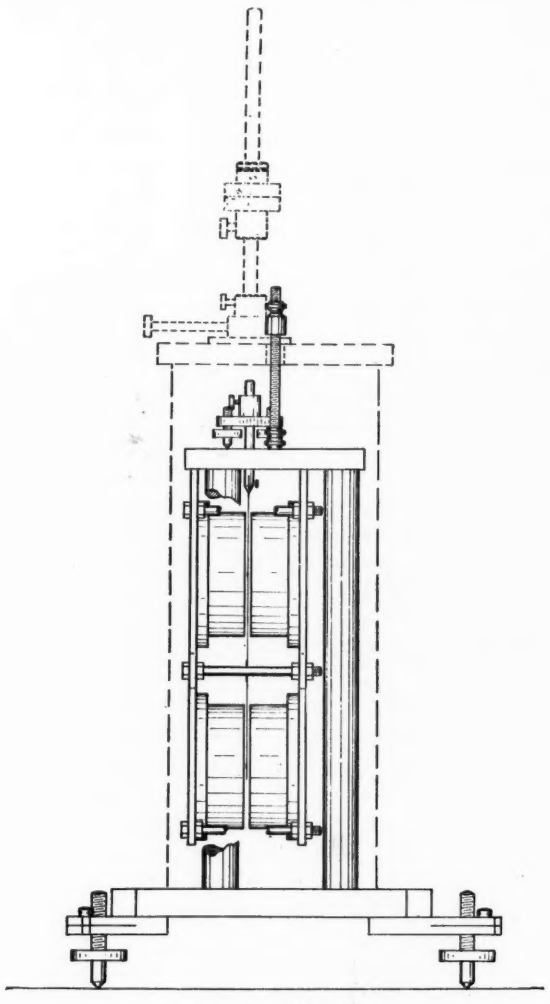


FIG. 2.—SIDE ELEVATION.

adjusted, may readily be removed and exactly replaced in its three conical holes.

An important feature of the suspension is the arrangement for attaching the fibre to the suspension rod. In using this suspension many of the awkward features which have given more or less difficulty are done away with. The fibre is first fastened to the centre of a small bit of paper by a minute drop of glue. Another bit of paper is glued to the face of the first, and the two bits of paper, holding the end of the fibre between them, are then pinched below the glue in a small screw clamp at the end of the suspension rod. A somewhat similar arrangement of bits of paper fastens the

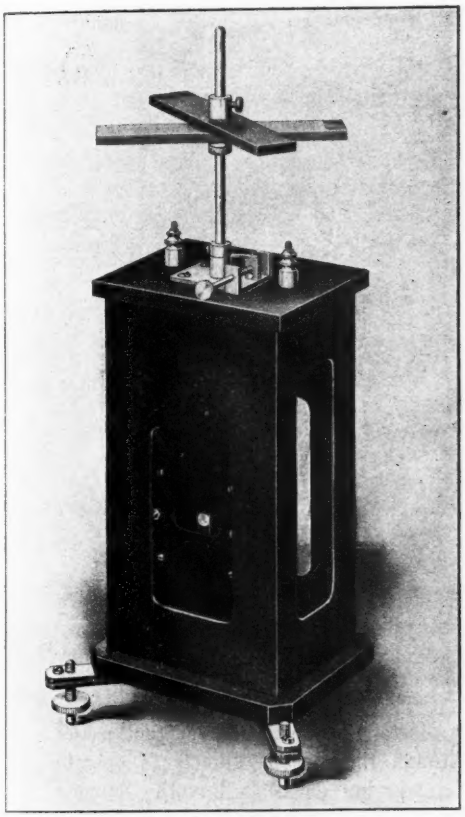


FIG. 3.—NEW KELVIN GALVANOMETER.

fibre to the top of the needle system. When the galvanometer is to be used solely with a dead-beat needle system, or solely with a ballistic system, a somewhat simpler apparatus for suspending the fibre and needle system is supplied. With this suspension device the needle system is adjusted once for all, and remains in position until, on account of breakage or for some other reason, it is desired to replace it by a new system.

The coils have the proportion of diameter to axial length, which theory points out as giving the maximum torque on the needle for a given volume of coil. The section of the coils is rectangular, the claim being made that the small percentage of gain due to a theoretical spheroidal shape of coil is more than offset by the greater closeness of winding, and by other mechanical advantages of the cylindrical coil. The coils are wound up with a tenacious wax into a practically solid block, having an ebonite core and back, and are securely attached to the coil plates in such a manner as to be readily accessible and open to inspection, at the same time being thoroughly protected from accidental injury. The coil plates are of ebonite, and are firmly held together and mutually adjusted by six distance rods with double nuts, the back plate being adjustable through a certain distance by means of these rods. With the aid of the slight flexibility of the plates, each pair of coils is independently adjustable.

The main terminals of the galvanometer are at the top of the instrument, passing up through the cover through openings large enough to leave an air space around the terminal rods when it is desired to take advantage of all the insulation furnished by the ebonite supporting columns. In the ordinary use of the instrument, however, the terminal binding nuts are screwed down upon the cover, closing these openings and leaving the interior of the instrument tightly closed against the external air, moisture and dust.

Fig. 3 shows the assembled instrument, and by reason of the glass plates on the front, back and sides of the cover, the instrument is open to inspection at all times.

Series Transformers for Instrument and Switch Work.

The Wagner Electric Manufacturing Company, St. Louis, Mo., is placing on the market a line of series transformers for instrument and switch work in several designs, some of which are illustrated in the accompanying engravings. These designs have each been determined with the view of affording peculiar fitness for a particular kind of work. The rating of these transformers is based upon the apparent watts delivered to the apparatus in the secondary circuit when operated on a sixty-cycle system, although various styles will operate satisfactorily within slightly modified limits for any frequency between 25 and 133 cycles. The design of construction, the company states, is such as to create a neat appearance, and to assure a high degree of insulation resistance between primary and secondary, and within their rated capacities these transformers may be relied upon for accurate current transformation. All coils are given an insulation test between windings of at least two and one-half times the volt-

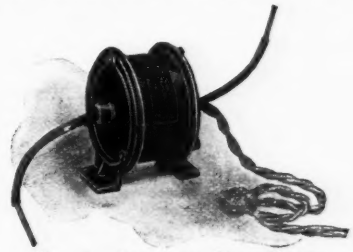


FIG. 1.—CAPACITY, TWO WATTS.

age of the circuit on which they are to be used.

Fig. 1 shows the type "R" transformer, which has a capacity of two watts. This is designed for use with indicating ammeters and wattmeters, and is of ample capacity for furnishing current for these instruments. It is intended that one transformer shall be used with each instrument, although in special cases, where desired, an ammeter and wattmeter may be supplied from the same secondary. This practice is recommended only where

FIG. 2.—CAPACITY, TEN WATTS.

room on the rear of the switchboard is extremely limited. Each instrument should be calibrated with its own transformer, as winding ratios of this type are not reliable within one and one-half per cent. This type of series transformer readily lends itself to service where it is desired to slip the coil over a switch stud. When so used, the supporting brackets are not furnished. For 15,000-volt coils a porcelain tube is used to insulate the pri-

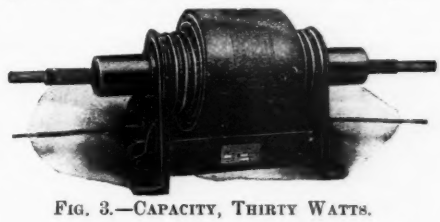


FIG. 3.—CAPACITY, THIRTY WATTS.

mary from the secondary winding, and, where desired, the company will supply on the 4,000-volt form of this coil a six-inch by one and one-quarter inch by one and three-sixteenth-inch porcelain tube for 300, 400, 500, 600 and 750 amperes capacity. Fig. 2 shows the type "S," capacity ten watts. This form is used for certain kinds of switch work, and is especially designed to afford a high degree

of insulation between primary and secondary windings. Fig. 3 shows the type "K," capacity thirty watts. This form of transformer is recommended for all sorts of miscellaneous work, and where space and first cost are not a consideration. The construction is substantial, and affords very high insulation between primary and secondary.

Type "O," capacity twenty watts, is for voltages in excess of 15,000. The windings are immersed in oil, and may be safely used on any circuit up to a pressure of 45,000 volts.

Automatic Telephone Equipment.

The Automatic Electric Company, Chicago, Ill., has begun the shipment of automatic telephone equipment to the Dayton Home Telephone Company, of Dayton, Ohio, and the Citizens' Telephone Company, of Grand Rapids, Mich. The Dayton company will begin business with 6,000 stations, and its ultimate capacity will be 19,000. The Grand Rapids company will have a present installation of 5,000, with an ultimate capacity of 19,000. Both of these companies have erected new buildings which were designed especially for the automatic exchange. An interesting feature of both of these large installations will be that no party lines will be used, each subscriber having a private wire. These, with the exchange of the Illinois Telephone and Telegraph Company, in Chicago, will be the largest telephone exchanges in the world to give such service.

The Automatic Electric Company is also manufacturing complete equipment for the Citizens' Telephone Company, of Columbus, Ohio, in which plant 7,000 stations will be installed at first, with an ultimate capacity of 19,000. The Northeastern Telephone Company, of Portland, Me., has also placed an order with the Automatic Electric Company for 2,500 telephones and switches, the switchboard to have a capacity of 10,000.

Out in Iowa the excellent service which has been given for seven years by the automatic system in the city of Manchester is having a wide influence. The recently organized Commonwealth Telephone Company has placed an order with the Automatic Electric Company for the equipment of 1,200 stations, with a capacity of 10,000. An order has also been given by the Wettstein Construction Company, which will build the new exchange in Burlington, Iowa. This order calls for the present equipment of 800 stations, and an ultimate capacity of 10,000.

Push-Button Switches.

The Marshall-Sanders Company, 301 Congress street, Boston, Mass., is doing a very large business in the distribution of its new push-button switches. This switch has been recommended and adopted by prominent engineers all over the country. The manufacturer claims for this apparatus an advanced design and the highest grade of workmanship. This switch, which is designated as M-S. No. 532, works very easily and stands severe electrical and mechanical strains. The parts of this switch are made by Styrian steel tools and are accurate to one-thousandth of an inch. The switches are not only economical to wire but are simple in design, especially in the matter of face-plates, one kind fitting all specifications.

Circuit-Breakers.

The S. K. C. circuit-breaker, illustrated herewith, embodies a number of features which distinguish it from similar devices. Prominent among these is the independent opening action. It is impossible to close the breaker on an overload. Should an attempt be made to do so, the closing toggle will be automatically disconnected from the operating handle and the jaws will open, regardless of the pull which is being applied to the handle, the instant that sufficient current passes through the carbon contacts to operate the tripping device. Thus the dangers which have hitherto existed resulting from circuit-breakers being forced in upon an overload are here eliminated. To trip by hand, the closing action is simply reversed; *i. e.*, the operating handle is pushed up.

By an ingenious arrangement of the iron core and the magnet coil, two turns are made around the core in a limited space. The iron core consists of two parts, one fixed and the other movable, which are so arranged as to have but one air-gap in the magnetic circuit. The movable portion of the core operates the tripping device, as can be seen in Fig. 4.

The main contact blocks are bridged

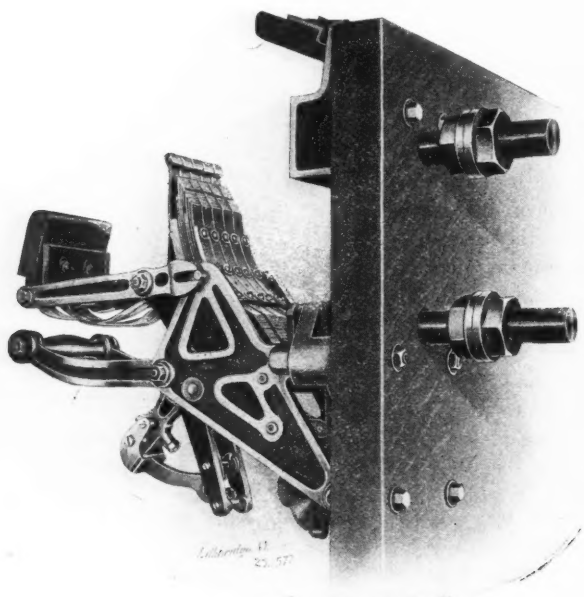


FIG. 1.—CIRCUIT-BREAKER, OPEN.

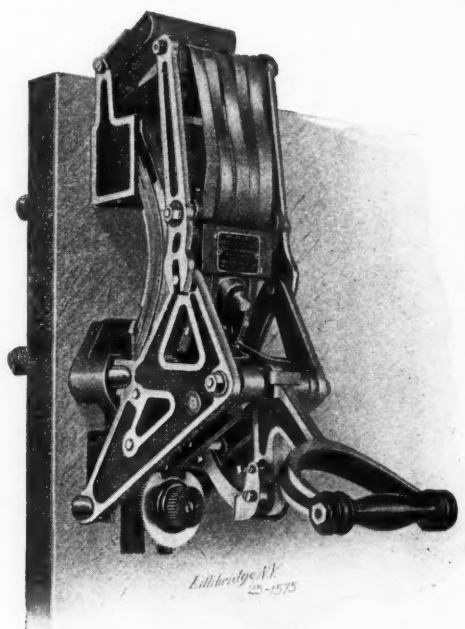


FIG. 2.—CIRCUIT-BREAKER, CLOSED.

by a sectional laminated copper arm, each section of which may be adjusted separately to secure the best contacts and attention is called to the ease with which the adjustment is accomplished. The main contact blocks are fastened to the marble base independently of the studs, which may be of any length to suit the switchboard construction.

The arrangement of the arc-rupturing carbons is unique, as compared with circuit-breakers made with fixed carbon blocks with parallel faces. In the S. K. C. vice, a feature which in other breakers has been most satisfactory. In the S. K. C., this consists of a rack, having a projecting bracket upon which rests the movable section of the magnetic core, and a pinion, engaging therewith, at the end of a short shaft which carries on its outer end a helical spring, a notched dial and an insulated knob, the arrangement of these parts being clearly shown in Fig. 4. It will be evident that by rotating the dial, the air-gap in the tripping magnet may be varied and a fine adjustment se-

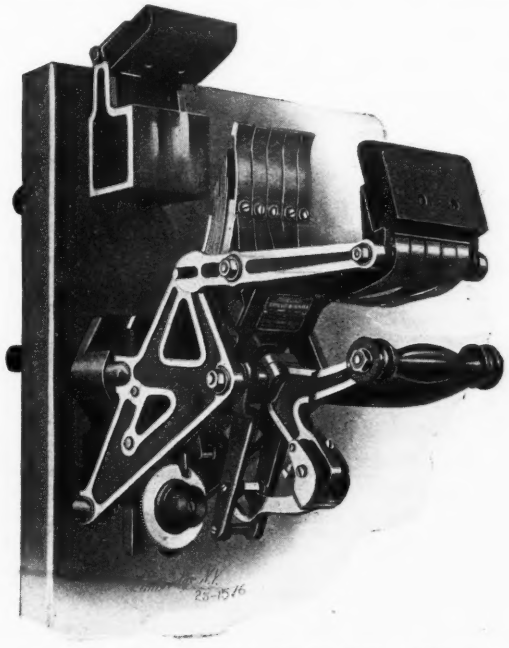


FIG. 3.—S. K. C. CIRCUIT-BREAKER, OPEN.

these carbon blocks have a certain amount of spring-actuated movement and come together with a sliding action, as can be seen from the illustration, which renders their breaking impossible. The surfaces are unusually large and the rubbing action taking place between them when the breaker is opened or closed ensures clean contacts. As will be seen from the illustrations of the breaker opened, Figs. 1 and 3, a long break between the carbons is secured with a comparatively short movement of the main contact arm, and arcing occurs at a safe distance from all metal parts.

It should be noted that in addition to the shunt circuit through the carbon contacts, there is also an auxiliary shunt composed of smaller copper arms which remain in contact momentarily after the main contacts are opened, thus further protecting the latter. The contact arms, both the main and the auxiliary, are clearly shown in Fig. 1.

An especial point of construction in the S. K. C. circuit-breaker is the setting de-cured. The operation of setting consists simply of pushing the knob, so that the dial is free from the index pin holding it secure, and rotating it until the figure indicating the desired tripping point is opposite the index pin. On releasing the knob, the dial springs out and locks itself to the pin. The large diameter of the setting dial gives, on its periphery, a scale approximately nine inches long.

These circuit-breakers operate on either direct or alternating-current circuits and are made in capacities from 200 to 3,000 amperes. They were designed by the engineers of the Stanley Electric Manufacturing Company, of Pittsfield, Mass., and are being put on the market by that company.

Turbine Shipments.

An interesting shipment of large steam turbine machinery has recently been made from the shops of the Westinghouse Machine Company, Pittsburg, Pa., which will be the first turbines of a large size and of American manufacture to be exported from this country. The shipment consisted of two 1,000-kilowatt Westinghouse turbine generating units of the most recent design. They are destined for light and power service in the De Beers mines, at Kimberly, South Africa.

Steam turbine equipments have also within the last month been shipped from the Pittsburg factory as follows: The B. F. Goodrich Company, Akron, Ohio, one 400-kilowatt unit for supplying light and power to shops; the Johnson Harvester Company, Batavia, N. Y., one 400-kilowatt unit for furnishing power to

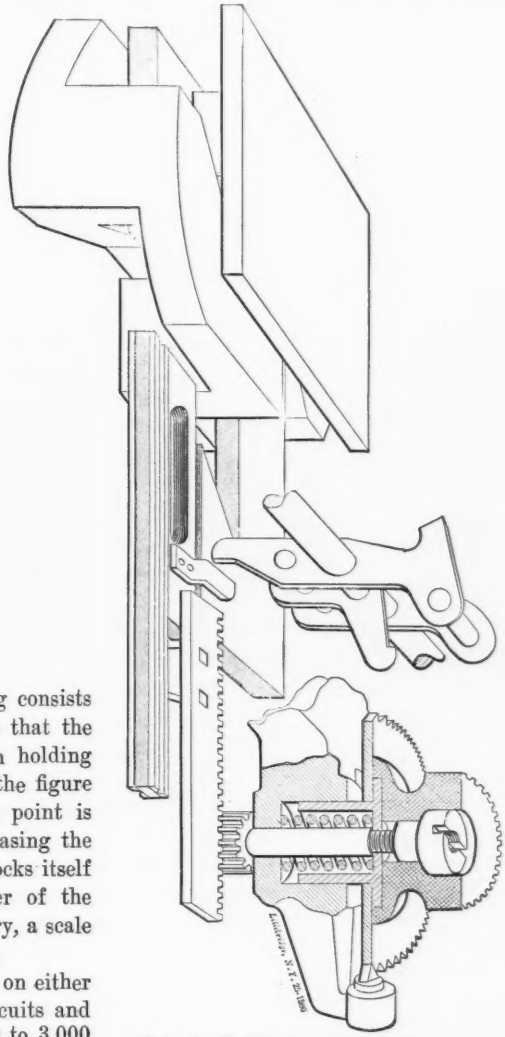


FIG. 4.—S. K. C. CIRCUIT-BREAKER. ARRANGEMENT OF MAGNET COIL AND CORE AND OF SETTING DEVICE.

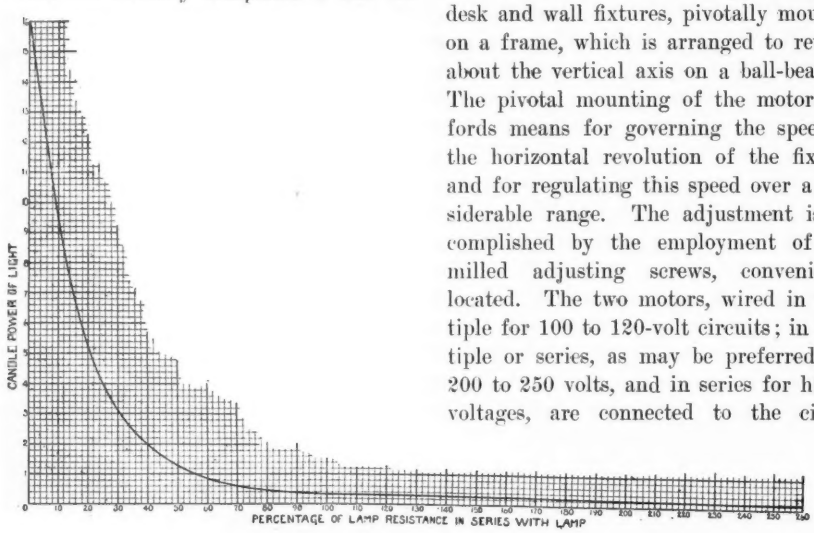
shops; the Consolidated Railways Light and Power Company, Wilmington, N. C., one 400-kilowatt unit for railway and lighting service; the Nassau Light and Power Company, Roslyn, L. I., one 400-kilowatt unit for local lighting, and S. D. Warren & Company, Cumberland Mills, Me., one 400-kilowatt unit for furnishing light and power to the company's mills, located at this point.

The Rome Brass and Copper Company,

Rome, N. Y., has just placed an order with Westinghouse, Church, Kerr & Company for a steam turbine power equipment for a new rolling mill at Rome, N. Y. The present properties of the Rome Brass and Copper Company are located upon the banks of the Mohawk River, at Rome, N. Y., and comprise a number of rolling mills and other buildings, scattered over a considerable area. The manufacturing facilities afforded by these mills being inadequate, the company has under way a number of new mills located at a short distance from the old plant and arranged with special reference to the ultimate centralization of motive power. One of the new mills will be operated entirely by electricity from an adjoining power-house, where the boilers and turbine machinery will be located.

Candle-Power and Resistance.

Professor J. W. Langley, of the Case School of Applied Science, Cleveland, Ohio, has recently completed a test for the Wirt Electric Company, of Frankford, Philadelphia, Pa. The test was made to show the degrees of candle-power and resistance in series with incandescent lamps in relation to the operation of theatre dimmers. From this test a curve has been drawn, and this curve enables the designer of a dimmer to properly proportion the different steps in the resistance, and indicating the total amount of resistance that can be used effectively.



CURVE SHOWING CANDLE-POWER WITH RELATION TO LAMP RESISTANCE IN SERIES.

Referring to the illustration accompanying, which has been reproduced from the curve, it is seen that the candle-power drops rapidly from the full intensity to a little less than one candle-power with sixty per cent of the lamp resistance in series with it. From this point the curve shows an approximately straight line down to 0.2 of a candle-power, the curve ending with 2.6 times the resistance of the lamp in series with it. This curve shows the required resistance for any dimming effect to 0.2 of one candle with a sixteen-candle-power lamp. If extended, the curve would reach zero at about 1,000 per cent, or in other words, to bring the lamp down to a black carbon (viewed in the dark) ten times the hot lamp resistance will be needed. These data are correct for incandescent lamps with an efficiency of 3.1 watts per candle.

The Gyrofan.

The accompanying illustrations show a new departure which the Jandus Electric Company, of Cleveland, Ohio, is placing on the market. This apparatus is designated as the Gyrofan, Fig. 1 showing the fan with the interchangeable ceiling fixture. Mechanically, the Gyrofan consists of two Jandus fan motors, identical with the well-known types used on desk and wall fixtures, pivotally mounted on a frame, which is arranged to revolve about the vertical axis on a ball-bearing. The pivotal mounting of the motors affords means for governing the speed of the horizontal revolution of the fixture, and for regulating this speed over a considerable range. The adjustment is accomplished by the employment of two milled adjusting screws, conveniently located. The two motors, wired in multiple for 100 to 120-volt circuits; in multiple or series, as may be preferred, for 200 to 250 volts, and in series for higher voltages, are connected to the circuit through the medium of copper slip rings and bronze contacts. A small wrist joint permits the blast from the fans to be directed downward, as desired. The force utilized in the revolution of the motors about the vertical axis results from an angular adjustment of the motor shafts with respect to the plane of the vertical axis of the fixture, and is equal to the reaction of the fan blades, multiplied by the perpendicular distance from the produced motor axis to the vertical fixture axis. The resulting torque may be increased or diminished by the horizontal adjustment of the motors on their respective supports. The governing feature above mentioned utilizes the centrifugal force of the motors revolving about the vertical axis to operate a brake, the action of which produces a uniform motion capable of control by adjusting screws.

Fig. 2 shows the Gyrofan ceiling fixture, with electrolier attachment. This fixture is furnished with nipples and cir-

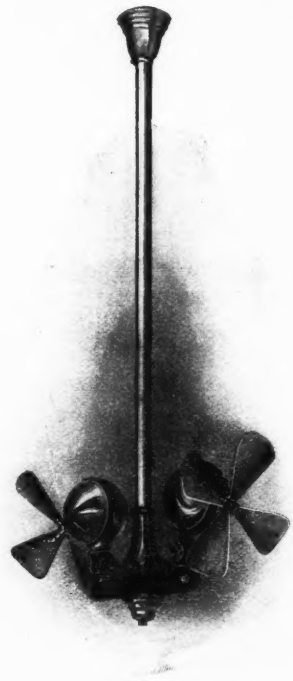


FIG. 1.

cuit taps, for attaching lamps, sockets, globes or shades, to suit the requirements. A four-point switch at the bottom of the fixture controls the motors and lamps sep-

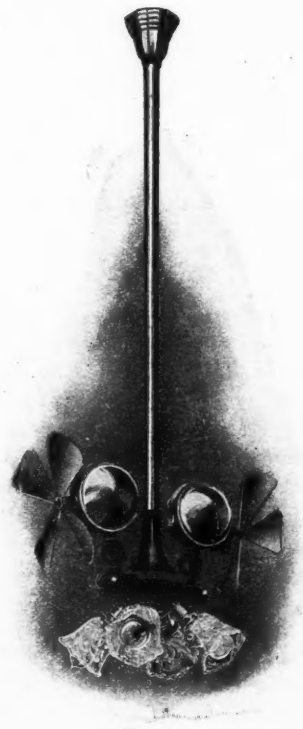


FIG. 2.

arately or in combination, dispensing with the necessity of an individual switch for the lamp circuit, with its concomitant requirements.

Heating and Ventilation of Railroad and Other Shops.

While railway shops and other one-story buildings of the same nature are very simple in construction, they are not so simple as might appear in regard to the problem of effectively and efficiently distributing heat and air. On account of the large amount of roof, wall and window surface, the loss of heat is very great, and also, because of this and the relatively great height of the building considered as a single room, there is a tendency toward unequal distribution of the heat, the warm air rising to the roof and the cold air flowing to the floor.

The distribution of the air by means of pipes should be so carried out that the lower part of the room is kept at a comfortable temperature, while at the same time no disagreeable drafts are produced. It has been found that by properly proportioning and directing the delivery flues most satisfactory results can be secured. Illustrating this point, some very interesting examples are cited by Mr. C. H. Gifford, of the B. F. Sturtevant Company, as follows:

"As an example of what can be accomplished by distribution, I have in mind a machine shop, that of the New York Shipbuilding Company, which as a machine shop is not dissimilar to one designed for railroad work. It has a building which, I believe, is about 1,100 feet long, about 250 feet wide and 82 feet high. The proposition was to heat one-half of this building and leave the balance of it unheated. We conceived the idea that there could be a partition put across the middle of the building about twelve feet high, and we could then bring the heated air down to the zone which it was desired to heat, which was not over eight feet above the floor, and in that way we could perhaps confine the air in the space, and not have very much effect on the rest of the building.

"The apparatus is arranged under the landing platforms of the gallery which surrounds the shop, so that it is out of the way of the cranes. Pipes are carried along beneath the runway of the cranes and branches are brought down on the posts and discharge the air toward the floor, the outlet being in the form of a Y, which is adjustable.

"We were very much gratified after the plant was started to find that it performed just as was expected it would, and it is surprising to note the difference in temperature between the two sides of that partition; it is almost the same as when you pass from the building out of doors. The result is simply due to the fact that the air was brought down and continually pressed down into the space which it was desired to heat."

Further emphasizing the advantages of correct distribution, Mr. Gifford says that it is "possible in some cases to introduce $50 worth of additional pipe to carry the air where it is most needed, so that you can, on account of this, leave out $100 worth of heating apparatus. That is, you can get equal results by using smaller apparatus and less steam."

The adoption of the fan system renders the control of the heating apparatus and of the ventilation ideal. During very cold weather, or in the morning when the building is being heated up, the air supply may be drawn from within the building itself, thus effecting a great economy of heat. In some buildings, having a very high cubic space per occupant, sufficient ventilation during the winter time will be supplied by the leakage of air through doors and crevices about the windows, by transfusion. Mr. E. T. Child, also of the Sturtevant company, says:

"We have found the most satisfactory heating will result from numerous pipes discharging on the outside walls at a point about six feet to eight feet above, and directed toward the floor. These pipes should be located from twenty-five to forty feet apart, depending upon the character of the building. This arrangement causes hot air to be blown downward, whence it spreads on the floor, keeping it warm before the air has a chance to follow its natural tendency and ascend to the roof. Hot air has a very bad faculty of getting up in the trusses and if you blow the air directly at the floor and get the floor warm, at the same time keeping the outside of the building warm, your problem is practically solved. In the case of an underground duct, it is well to use short outlet pieces which will discharge the air along the walls at the floor.

"At the works of the Fore River Ship and Engine Building Company, there is an overhead pipe system with drops on the walls, which was put in according to the regular practice. Later it added fifty per cent to the building and is now heating it with the same apparatus. That is, we picked out a fan heater which we considered to be the proper size for that particular building and it worked in a perfectly satisfactory manner. Later the ship company added fifty per cent to the length of the building. We extended the piping and carried drops on the walls every thirty feet, blew the air on the floor with ample outlets on the ends, and in the coldest weather the heat of the building, which is fifty per cent larger than we would care to guarantee with our apparatus, was perfectly satisfactory to them. Their success is entirely attributed to the excellent system of air distribution.

"At the shops of the Atchison, Topeka & Santa Fe Railway Company, the underground system was adopted and low horizontal outlets were provided which distribute the air at the floor and along the walls. This is an extremely large shop, the contents being about 4,000,000 or 5,000,000 cubic feet. The shop is heated by four large apparatuses and the underground ducts extend almost entirely around the building. The pipes are not over three feet high, the air being discharged horizontally along the floor, and I understand that the building is very satisfactorily heated.

"The galvanized iron pipe system with drop pipes on the walls has been used at the new shops of the New York, New Haven & Hartford Railroad, at Readville, Mass., and with excellent results.

"The following general classification of railway shops may be made:

"1. Machine, erecting and car shops.

"2. Paint shops.

"3. Round houses.

"The second and third require special treatment. Paint shops require to be practically dustless and, consequently, the air velocities must be low. The temperature requires to be higher, and it is customary to arrange to circulate the air in a much more thorough manner than in shops of the first class.

"This is done in the Pennsylvania Railroad shops at Altoona by means of ducts and in the New Haven shops, Readville, by a similar overhead system. There has been a great deal of hesitation among railroad men about installing the hot-blast apparatus in paint shops. They are afraid of getting their varnish dusty. But I might name a dozen or so paint shops all over the country; for instance, the Boston & Albany shops at Allison, the New Haven shops at Readville and there are several western shops, all of which are heated with the hot-blast system by a very ample distribution of air. The circulation is brought about by a counter-exhaust system, which circulates the air, returning the whole or a part to the apparatus. There are two ways of establishing this return of the air; one by an underground duct system, and the other by an overhead galvanized system. In the Pennsylvania Railroad shops at Altoona we have an installation that has been in a dozen years. I think it is one of the first we put in that returned the air from underground and back to the fans,

using very ample distribution of air-pipe in the discharge.

"In the Readville shops the air is brought back by means of an overhead galvanized pipe. In this way circulation is kept up in all parts of the room and thereby the paint is dried much more rapidly than it would be by any other system where the air in the room is practically still.

"Round houses have been much neglected up to recent years, but of late they have been receiving better attention. Their proper heating is a problem of no little moment.

"The hot-blast system of heating is a great improvement over the old method, since it allows for ventilation in the winter time with both windows and doors closed. In this class of buildings the air should be delivered through ducts which terminate in the walls of the pit, thus delivering the air where it will be most effective for thawing out engines that have come into the house covered with snow and ice. At the same time it is a very good idea to have a provision for admitting some of the air above the floor in case there are no locomotives which need special attention."

As further touching upon the subject of paint shops, Mr. Gifford stated that he has been told by a prominent railroad engineer, "that aside from the question of heating a shop, the drying of the paint and varnish is a chemical question and, for that reason, the advantage of the hot-blast system lies in the fact that you can handle large quantities of air, so that you have an active circulation and rapid impingement of the air upon the painted surface, causing a rapid oxidation of the paint and varnish."

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

ASSOCIATES ELECTED AT THE DIRECTORS' MEETING, NEW YORK, FRIDAY, APRIL 24, 1903.

Nicolai Aall, Brooklyn, N. Y.
Charles Antony Ablett, Schenectady, N. Y.
Seth C. Adams, New Rochelle, N. Y.
Albert Edwin Alkins, Lynn, Mass.
Rodney D. Allen, Philadelphia, Pa.
Eugene Cyrus Bacot, Duluth, Minn.
Frederic Fries Bahnson, New York city.
Alvin M. Ballou, Denver, Col.
John C. Barclay, New York city.
James Edmund Barker, Pasadena, Cal.
John Martin Barnay, Norwood, Ohio.
John G. Barry, Schenectady, N. Y.
Ralph Hamilton Beach, New York city.
Elias H. Beckstrand, Salt Lake City, Utah.
La Monte J. Belnap, Montreal, Quebec.
William G. Bee, Glen Ridge, N. J.
Edgar Bryant Benjamin, New York city.
George Hewes Berg, Medford, Mass.
Otto Bergen, Goldstream, British Columbia.
Edgar Henry Berry, New Brighton, N. Y.
Herman Matthews Biebel, Chicago, Ill.
George Welton Bissell, Ames, Iowa.
S. Henry Blake, Jersey City, N. J.
William A. Blanck, Chicago, Ill.
Kenneth McClure Bradley, Lynn, Mass.
James A. Brett, Chicago, Ill.
Carl Gordon Brightman, Dorchester, Mass.
Robert T. Brooke, Jr., West Lynn, Mass.
James Russell Broughton, Norris, Mont.
Theodore J. Brown, Portland, Me.
Arthur Richmond Bush, Cambridge, Mass.
Charles I. Burkholder, Schenectady, N. Y.
Alexander Hamilton Burritt, Lynn, Mass.
William Oscar Burson, Lynn, Mass.
John Starr Butler, New Dorchester, Mass.
Frederick Cabrera, Hoboken, N. J.
Lawrence Whittredge Cady, Lynn, Mass.
Eliot L. Caldwell, Jamaica Plain, Mass.
Walter E. Carpenter, Lynn, Mass.
Walter Frank Carr, Wilwaukee, Wis.
Thomas Cecil, New York city.
Charles Albert Chase, Dorchester, Mass.
Algernon Roberts Cheyney, Philadelphia, Pa.
Charles Weston Clark, Berkeley, Cal.
Curtis Claypoole, Columbus, Ohio.
Robert Barter Cochran, Lynn, Mass.
George Henry Conant, Melrose, Mass.
Julien Jewett Crawshaw, St. Louis, Mo.
Herbert W. Crozier, San Francisco, Cal.
George Cruikshank, Montreal, Quebec.
William M. Cummiskey, East Orange, N. J.
Harry Allan Currie, Brooklyn, N. Y.
Elihu Herbert Cutler, Springfield, Mass.
Charles Bridge Davis, Lexington, Mass.
William Tucker Dean, Chicago, Ill.
Clarence E. Delafield, St. Louis, Mo.
Henry C. Don Carlos, Clarksburg, Mo.
William Isaac Donshea, New York city.
Charles B. Doolittle, New Haven, Ct.
Egbert Douglas, Springfield, Ohio.
Bernard M. Drake, London, S. W., England.
Robert Rowse Dunlop, Columbus, Ohio.
Thomas A. Earll, Rensselaer, N. Y.
Leonard Lord Elden, Dorchester, Mass.
Ernest B. Fahnestock, New York city.
Robert Payne Fairbanks, Logan, Utah.
Harold Gilbert Farwell, Lynn, Mass.
Charles Arthur Fernald, Lynn, Mass.
Herbert Isaac Finch, St. Louis, Mo.
George Edward Fisher, Natick, Mass.
John Barclay Fisken, Spokane, Wash.
Joseph C. Forsyth, Brooklyn, N. Y.
Myron Marshall Fowler, Chicago, Ill.
H. J. Fuller, Beeston Hill, Leeds, England.
Elbert Ellsworth Gage, Johnsbury, Vt.
Stephen Gardner, Chicago, Ill.
W. O. Garrison, St. Louis, Mo.
E. E. Gilbert, Schenectady, N. Y.
Harry Gillett, Cleveland, Ohio.
Fred J. Green, Springfield, Ohio.
George Ross Green, Philadelphia, Pa.
Walter Atwood Hall, Lynn, Mass.
William Albert Hall, Madisonville, Ohio.
David Halstead, Philadelphia, Pa.
Richard Benjamin Hampson, Lynn, Mass.
Max Ross Hanna, Schenectady, N. Y.
William Hand, St. Louis, Mo.
Edwin Partridge Harder, Buffalo, N. Y.
James Harrison, St. Louis, Mo.
Charles E. Harthan, Lynn, Mass.
William James Harvie, Utica, N. Y.
George Hays, Bloomfield, N. J.
Robert F. Haywood, Salt Lake City, Utah.
William Ferris Hendry, New York city.
Herbert H. Hess, Schenectady, N. Y.
Frederick S. Hickok, Berwyn, Ill.
Joseph S. Hill, Washington, D. C.
George Hanwood Hodges, New York city.
Joseph E. Hodgson, Mount Vernon, N. Y.
Harry Milford Hope, Chicago, Ill.
Ernest Grant Howard, Springfield, Mass.
Samuel Parker Hunt, Binghamton, N. Y.
Walter Simeon Hunt, Schenectady, N. Y.
James Tyler Hutchings, Philadelphia, Pa.
James C. Hyde, Peterborough, Ontario.
Henry Docher Jackson, Boston, Mass.
Claude Minnis Janes, Pittsfield, Mass.
Thomas Irving Jeffries, New York city.
George G. Jobbins, Melbourne, Victoria.
John Johnson, Lynn, Mass.
Roland Arthur Joslyn, West Lynn, Mass.
Frederick Morton Jourdan, Lynn, Mass.
John Bryant Ketcham, New York city.
Fred Mason Kimball, Somerville, Mass.
Charles G. Y. King, Chicago, Ill.
Emil O. E. Klipphahn, Schenectady, N. Y.
Climpson Moore Knight, Amsterdam, N. Y.
James Kynoch, East Toronto, Canada.
Walter Laile, Cincinnati, Ohio.
Edward N. Lake, Chicago, Ill.
William J. Lansley, Woodbridge, N. J.
John Emery Lear, Lynn, Mass.
John Joseph Leary, New York city.
Albert W. Lee, Concord, Mass.
Lehman Levy, New York city.
Frederick M. Locke, Victor, N. Y.
Willard Ross Lyall, Boston, Mass.
James Leslie Mackay, West Lynn, Mass.
George Macloskie, Jr., Schenectady, N. Y.
Lewis George Martin, Brooklyn, N. Y.
Howard Maxwell, Schenectady, N. Y.
Clarence Mellshope, Cincinnati, Ohio.
Ernest McCleary, Detroit, Mich.
John Angus McCoy, Somerville, Mass.
Edgar Jerome McDuffee, Lynn, Mass.
John J. McLoughlin, New York city.
Francis Regester Meginniss, Lynn, Mass.
William S. Merkle, St. Louis, Mo.
Barrett Morris Merrill, Kent, Wash.
John Wilhelm Meyer, Philadelphia, Pa.
Alvin Augustus Miller, Seattle, Wash.
Frederick Rutherford Mott, St. Louis, Mo.
Edward J. Murray, Schenectady, N. Y.
Alvin H. Moraweck, Pittsburg, Pa.
Charles Ketcham Nichols, Brooklyn, N. Y.
Perry Okey, Columbus, Ohio.
William Weaver Olheiser, Camden, N. J.
Andrew J. O'Reilly, St. Louis, Mo.
Leonard Warren Packard, Lynn, Mass.
Walter Ambrose Pearson, New York city.
James William Perry, New York city.
Charles Carroll Pierce, Brookline, Mass.
William Pestell, Worcester, Mass.
Mathias Pfatischer, Philadelphia, Pa.
Ezra James Pietczker, Chicago, Ill.
James A. Price, Brooklyn, N. Y.
James C. Ramsey, Jr., Methuen, Mass.
Robert Carter Reed, Conneaut, Ohio.
Harry Webb Richardson, Beachmont, Mass.
Charles Robbins, Montclair, N. J.
Ernst Ruebel, St. Louis, Mo.
Earl Sanford, Wilkinsburg, Pa.
George Edwin Sanford, Lynn, Mass.
George Alfred Sawin, Lynn, Mass.
Walter Schmidt, Pittsburg, Pa.
Rudolph C. Schönheider, Highwood, Minn.
Adolph William Schramm, Philadelphia, Pa.
Martin Schreiber, Cleveland, Ohio.
Rudolph Frederick Schuchardt, Chicago, Ill.
Robinett Scruby, New York city.
Andrew Kenneth Selden, Jr., Lynn, Mass.
Charles Leslie Smith, Providence, R. I.
Harrison Arthur Smith, Indianapolis, Ind.
Howard F. Smith, St. Louis, Mo.
Louis Clarence Smith, Woodbury, N. J.
Edwin Hutchinson Smythe, Freeport, Ill.
Henry C. Spinney, Lynn, Mass.
Clarence E. Sprague, Dorchester, Mass.
Sven Olaf Stalberg, Lynn, Mass.
Robert Steck, Chicago, Ill.
C. E. Stephens, Victoria, British Columbia.
Tom Kennan Price Stilwell, Lynn, Mass.
William Renwick Steinmetz, Pittsburg, Pa.
Robert Boorman Strong, Plainfield, N. J.
Carl A. E. G. Stueve, New York city.
John William Swaren, West Lynn, Mass.
Alfred Robert Tahl, Brooklyn, N. Y.
Neil Taylor, Hunthill, Coatbridge, Scotland.
David Rades Thomas, Hokendauqua, Pa.
Ralph Fowler Thompson, Liverpool, Ohio.
Edmund J. G. Tower, Buffalo, N. Y.
George B. Tripp, Colorado Springs, Col.
Victor Morris Tyler, New Haven, Ct.
Albert Uhl, Shreveport, La.
Arthur J. Underwood, Bellevue, Ky.
Louis Edward Underwood, West Lynn, Mass.
Walter H. Underwood, Bellevue, Ky.
Siegfried Von Ammon, Rugby, England.
Edward T. Wagenhals, Trenton, N. J.
Charles Archibald Ward, Pittsburg, Pa.
Walter J. Warder, Jr., Chicago, Ill.
Dwight Edward Webster, Denver, Col.
John Allen Wells, Schenectady, N. Y.
Robert Filmore Wentz, Nazareth, Pa.
John Sanborn Whitaker, Dorchester, Mass.
Harold E. White, Schenectady, N. Y.
William W. White, Philadelphia, Pa.
Louis C. Whitehouse, New Brighton, N. Y.
John Bulkley Wiard, Lynn, Mass.
James A. Wilson, Boston, Mass.
W. T. Woodroofe, Vancouver, British Col.

TRANSFERRED FROM ASSOCIATE TO FULL MEMBERSHIP.

F. Darlington, Great Barrington, Mass.
William Esty, Bethlehem, Pa.
S. E. Johannesen, Pittsburg, Pa.
M. Von Recklinghausen, New York city.
Robert Robertson, Glasgow, Scotland.

CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

A EUROPEAN TRUST OF ELECTRICAL MANUFACTURERS—Important negotiations have been concluded in Berlin, Germany, for the organization of an international electrical corporation, embracing the American General Electric Company and the British Thomson-Houston Company with the newly formed German electrical syndicate, the Allgemeine Electricitäts Gesellschaft and the Union Company, of Berlin. This new corporation purposes to obtain control of the British and Continental markets.

NEW JERSEY POWER PLANT—The Trenton (N. J.) Water Power Company is preparing to establish a power plant on the lands of the company at the raceway leading into the Delaware River. This is at the lower end of the stream, where the water takes a decided fall, emptying into the Delaware River. Thousands of dollars will be spent in the construction of the large water-wheels that will operate dynamos and likely supply the electrical energy of the whole city. It is understood that the power, which will be exclusively by water, will easily equal the capacity of the plant of the South Jersey Gas, Electric and Traction Company, the Trenton Street Railway Company, and the numerous other electrical establishments of Trenton.

INDIANA TRACTION LINES IN A LARGE DEAL—It is announced that Messrs. J. Levering Jones and Bayard Henry and Stephen B. Fleming, of Fort Wayne, are associated with Mr. George F. McCulloch, president of the Union Traction and the Indianapolis and Northern Traction companies, have closed a deal for the purchase of the Logansport city electric railway system and the Wabash Traction Company, which is operating an electric line between Logansport and Wabash, a distance of forty-three miles. With the closing of this deal Indianapolis will be connected with Fort Wayne and Lima by a continuous electric line within the next few months, when the Indianapolis & Northern line, now building, will have been completed. These properties, it is stated, are valued at $25,000,000.

NEW YORK-BOSTON TROLLEY LINK—The Connecticut House of Representatives recently passed a resolution incorporating the Wallingford Tramway Company. The charter provides for the building of the final link of a continuous trolley line between New York and Boston. The company is authorized to build from the terminus of the Meriden Electric Company's lines in Wallingford South, through North Haven to Montowese, where connections are made with the Fair Haven & Westville Railway Company's system. The company is capitalized at $500,000. The charter carries power to make traffic agreements with connecting railroads, and it also gives almost unlimited authority of merger with gas, electric light, railway, or power companies. The incorporators are: Walter J. Leavenworth, Frank A. Wallace, George E. Dickerman, Charles B. Yale, and Ralph T. Ives, all of Wallingford.

MORE INDIANA TRACTIONS—A contract has been closed between the Eastern Indiana Traction Company, represented by Peter Schwab, of Hamilton, Ohio, and Alfred M. Lamar & Company, New York, bankers, represented by H. D. Reynolds, for the construction of an electric railway from Richmond to Marion, Ind., extending through Spring Grove, Chester, Fountain City, Lynn, Snow Hill, Spartansburg, Winchester, Woods, Stone Station, Deerfield, Ridgeville, Redkey, Dunkirk, Mill Grove, Hartford City, Renner, Upland, Gas City, Jonesboro and the Soldiers' Home, a distance of eighty-six miles, with contemplated extensions for a through line from Cincinnati to Chicago. Under the contract eighty-six miles of the road are to be completed within two years. The Mandelbaum interests, controlling the lines between Cincinnati and Toledo, are connected with the deal. Ex-governor James E. Campbell conducted the negotiations in New York, where Lamar & Reynolds have already organized the Interurban Financing and Construction Company for this and other similar enterprises. Construction will begin at once.

POWER PLANT AT WASHINGTON, D. C.—The Great Falls Power Company will be ready to let contracts for the construction of its plant within a few weeks. A corps of engineers, under chief engineer Sheriffs, has been making the plans and specifications for the plant, and is nearly through with this preliminary work. The concern will be capitalized at $2,500,000, and all or nearly all of the stock will be held by President McDermott and other stockholders of the Washington Railway and Electric Company. The two concerns will have no other connection, the water power company being a distinct corporation. The plans of the engineers call for the expenditure of nearly $2,500,000 for the plant, and the remainder of the capitalization will be used as working capital. The company will have a minimum of 20,000 horse-power from the falls, when the Potomac is at low water. Its machinery will be big enough to generate 70,000 horse-power daily. Steam engines will be run at times of low water to furnish sufficient power for the needs of the company above the minimum to be obtained from the water power. The Washington Railway and Electric Company will buy 18,000 horse-power from the company, thus assuring it a market for nearly all of its minimum supply at all times. It is said that the company can be run without a loss on the business it will do with the railway syndicate alone. The company owns tne Great Falls water rights for a long distance down the river, from the government water plant. It will generate its power by many wheels put in at different levels.

THE LONDON SUBWAY SYSTEM—Definite outlines for the organization plans of the London underground tube system have recently been announced. This is the organization in which Mr. Charles T. Yerkes and Speyer & Company are interested. The name of the company will be "The Underground Electric Railway Companies of London, Limited." The capital will be £5,000,000, of which fifty per cent has been paid in, the remaining fifty per cent subject to call. The articles of incorporation provide that for a period of ten years the majority of the board of directors shall be named by Speyer Brothers, of London, and Speyer & Company, of New York, and the Old Colony Trust Company, of Boston. The first board of directors will consist of the following: James Speyer, T. J. Coolidge, Jr., James A Blair, James H. Hyde, L. F. Loree, Robert H. McCurdy, Charles A. Spofford, the Right Hon. Lord Farrer, Major Ernest St. Clair Pemberton, Walter Abbott, Frank Dawes, Charles J. C. Scott, Edgar Speyer, Henry Teixeira de Mattos. Mr. Charles T. Yerkes will be chairman of the board. It is probable that the policy of the company will be to control different companies through traffic agreements and ownership of securities, or both, the bulk of actual capital to defray the cost of construction of each of the roads being obtained from the sale of guaranteed securities of the subsidiary companies, the dividends being guaranteed by the parent company. The new company now controls the Metropolitan District Railway, which is a shallow subway and surface road, owning its right of way in fee. In addition the new company is building three deep level tube roads, namely, the Baker Street & Waterloo, the Great Northern, Piccadilly & Brompton, and the Charing Cross, Euston & Hampstead. It also controls the United Tramways Company with many miles of surface roads running in a general westerly direction from around Shepherd's Bush and Hammersmith.

RECEIVERSHIP NOTE.

RECEIVER FOR ELECTRICAL GOODS MANUFACTURER—Norman W. Bingham, of Somerville, and Edward Davis, of Philadelphia, have been appointed by Judge Colt in the United States Circuit Court receivers for the Helios-Upton Company, Philadelphia, Pa., and Chicago, Ill. The receivers were appointed in a suit brought by King Upton, of Salem, a creditor with a claim exceeding $76,000 and the largest stockholder in the corporation. The debts of the company, it is alleged, exceed $235,000, and it is unable to pay them promptly. The receivers, who are appointed to conserve the interests of the creditors and the stockholders, are authorized and directed to carry on the business. Each gave a bond for $25,000.

ELECTRICAL SECURITIES.

The stock markets in the several prominent financial sections of the country were all a similar tone during the past week. Not that there is any likelihood of hurtful declines, but the condition suggests rather a desire to let things stand as they are, and it will probably take some development of more than ordinary importance, even though it proves of an adverse nature, to stimulate a more active speculative movement. Many large promoters are being forced to postpone new propositions, owing to the scarcity of takers of really good investments. Whether this is due to a growing extravagance on the part of the hitherto buying public, as has been seriously suggested quite recently, or whether it is a natural fear of depreciation of power due to anti-corporation legislation, it will take some time to determine.

However, conservative interests feel confident that with the good showing being made in all departments of industry, the prospects of fine crops, and the firm undertone characterizing money transactions, an upward tendency will shortly prevail.

ELECTRICAL SECURITIES FOR THE WEEK ENDING MAY 2.

New York:	*Closing.*
Brooklyn Rapid Transit	66
Consolidated Gas	211⅜
General Electric	193½
Kings County Electric	180
Manhattan Elevated	142
Metropolitan Street Railway	133½
New York & New Jersey Telephone	162
Westinghouse Manufacturing Company	210

Metropolitan improved on expectation of the district attorney's expert exonerating the management.

Boston:	*Closing.*
American Telephone and Telegraph	159
Edison Electric Illuminating	270
Massachusetts Electric	88
New England Telephone	138
Western Telephone & Telegraph preferred	96

American Telephone and Telegraph fell 1½ to 158½, closing at 159.

The report of the New England Telephone and Telegraph Company for the calendar year 1902, shows $847,187 increase in gross income and $131,286 increase in net, with 16,282 stations added to the exchange system, making 111,774 in all.

Philadelphia:	*Closing.*
Electric Company of America	9
Electric Storage Battery common	74
Electric Storage Battery preferred	74
Philadelphia Electric	7⅛
Union Traction	46¾
United Gas Improvement	107½

The annual report of the Electric Company of America shows net earnings for 1902 of $349,546, as compared with $281,382 in 1901, a gain of 24 per cent. The surplus account at the end of 1902 showed a credit of $453,776.

Chicago:	*Closing.*
Chicago Telephone	144
Chicago Edison Light	150
Metropolitan Elevated preferred	74
National Carbon common	24
National Carbon preferred	97
Union Traction common	6
Union Traction preferred	30

LEGAL NOTE.

TELEPHONE APPARATUS INFRINGEMENT SUIT—Injunction suits have been brought by the Kellogg Switchboard and Supply Company, of Chicago, in the United States Circuit Court, against the Stromberg-Carlson Telephone Manufacturing Company, of Rochester and Chicago, and the Louisville Home Telephone Company, of Louisville, Ky., asking that the former be restrained from infringing (by manufacture and sale) patent No. 718,855, granted to Kempster B. Miller, for a telephone wall set, and that the latter be restrained from infringing (by purchase and operation) reissue patents Nos. 12,031 granted to Francis W. Dunbar for a two-wire telephone system, and 12,090 granted to William W. Dean for a two-wire testing system.

TELEPHONE AND TELEGRAPH.

DENNISON, TEX.—The Smithville Telephone Company has been organized at Smithville with a capital stock of $20,000.

PIERRE, S. DAK.—The Belle-Selector Telephone Company, of Chicago, has been incorporated here, with a capital of $100,000.

COLLINSVILLE, MASS.—The Farmington Valley Telephone Company has voted to increase the capital stock from $18,000 to $27,000.

PORTLAND, ME.—Work has been begun on the system of the Northeastern Telephone Company. The work will cost more than $400,000.

GREEN BAY, WIS.—The Rapids & Western Telephone Company has been incorporated by E. S. Bedell, J. E. Paulson and Ole Stephenson.

NEW ALBANY, IND.—The Home Telephone Company has completed extensive improvements to its local service. About $100,000 has been expended.

BEATRICE, NEB.—The Filley Independent Telephone Company has been incorporated by P. M. Andersen, L. C. Andersen, R. Petersen and Harry Yohe.

ELKTON, MD.—The Peninsular Long-Distance Telephone Company has been organized, with a capital of $100,000, to erect telephone lines from Elkton to Cape Charles.

ROME, KAN.—A farmers' telephone company has been organized at Rome by Ivan Rogers, N. V. Williams, W. A. Carrington and O. M. Ruthernauff. The capital stock is $4,000.

CINCINNATI, OHIO—The Ohio Valley Telephone Company has been formed to consolidate the independent lines between Charleston, W. Va., and Cincinnati. The capital of the company is $200,000.

ST. ALBANS, VT.—At the annual meeting of the Addison County Telephone Company the following officers were elected: President, John A. James; vice-president, J. S. Dodge; treasurer and secretary, A. T. Calhoun.

SMITHVILLE, TEX.—The Smithville Telephone Company has been organized with the following officers: E. H. Eagleston, president; W. R. Searcy, vice-president; V. S. Robb, secretary and treasurer. The capital stock is $20,000.

MONTREAL, QUEBEC—The controlling interest in the Merchants' Telephone Company has been purchased for a United States syndicate by Mr. Arthur Johns, of New York, and the company has been reorganized on a new basis.

TENVILLE, IOWA—A new telephone company has been formed, under the name of the Villisca & Holmes Chappel Company, with the following officers: President, John Anderson; vice-president, J. H. Hargan, secretary and treasurer, H. H. Farlin.

CRAB ORCHARD, NEB.—The Crab Orchard Home Telephone Company is being formed to operate in southwest Johnson County, in addition to having an exchange in town. The company will be capitalized at $10,000, and work will begin as soon as possible.

ONAWA, IOWA—The Maple Valley Telephone and Telegraph Company has filed articles of incorporation with a capital stock of $100,000; $50,000 of which is common, and $50,000 preferred. The officers are: President, W. H. Leathers; vice-president, J. C. Hammond; secretary, C. H. Smith; treasurer, T. B. Lutz.

LANCASTER, N. Y.—The Farmers' Telephone Company has been organized here by local men. The officers of the company are: President, George Beck; vice-president, E. R. Ives; secretary and treasurer, Heran Brunck. The company already has part of its line constructed, and additions will be made shortly.

PAVILION, N. Y.—A meeting of the Oatka Valley Telephone Company has been held, at which a permanent organization was effected and the following officers elected: J. C. Doty, president; Fred Chilson, vice-president; George Bernd, secretary; George I. Carr, treasurer. The proposed line will extend from the Bunce farm on the north to Pearl Creek at the south, east to Union Corners, Peoria, La Grange and Covington; west to Bethany and East Bethany.

PERSONAL MENTION.

MR. LITTLEDALE BENTLEY, of Glasgow, with the Electrical Power Storage Company, of London, is visiting in the United States.

MR. C. E. TRUMP, president of the Novelty Electric Company, of Philadelphia, was one of the many visiting electrical men in New York last week.

MR. N. W. LILLIE, of the New England Telephone and Telegraph Company, Boston, was a New York visitor last week, spending several days in the metropolis.

MR. H. DURANT CHEEVER, manager of the Okonite Company, and Mrs. Cheever, sailed for Europe Saturday of last week. They will spend several weeks in London and Paris.

MR. MILTON J. BUDLONG has been elected president of the Electric Vehicle Company, of Hartford, Ct., vice Mr. George H. Day, who has resigned the presidency. Mr. Day will remain on the directorate of the company.

MR. A. M. YOUNG, vice-president of the Kings County Electric Light and Power Company, and Mrs. Young, sailed for London on Saturday of last week on the Minnetonka, and will spend a month on the water and in London.

MR. GEORGE T. HANCHETT has removed his offices to the Engineering Building, 114 Liberty street, New York city. Mr. Hanchett is well-known among the electrical fraternity, and it is his intention to provide a convenient laboratory and testing facilities in his new headquarters.

MR. ARTHUR D. WHEELER has been elected president of the Chicago Telephone Company, succeeding Mr. John I. Sabin, who returns to San Francisco to look after his interests there. Mr. Angus S. Hibbard, formerly general manager of the company, becomes vice-president. Mr. L. G. Richardson was elected president of the Central Union Telephone Company.

MR. EDWARD R. TAYLOR, Penn Yan, N. Y., was a New York visitor last week. Mr. Taylor announced his intention of sailing for Europe May 12, where he will attend the meetings in Berlin of the International Congress of Applied Chemistry, as a delegate of the American Electrochemical Society and the Society of Chemical Industry. It is also expected that Mr. Taylor will prepare a paper to be read before this congress.

MR. ROBERT L. ELLIOTT, Chicago, Ill., "Reporter on Theft of Current," is preparing a complete report for the Chicago convention of the National Electric Light Association, May 26, 27 and 28, describing different ways in which electric current is stolen, showing the means for detecting the guilty parties, and suggesting methods for preventing the possibility of theft. The report will also show which of the states has laws for punishing this crime, and what uniformity exists in the laws of the different states. Effort is being made to have a uniform law enacted in all of the states.

ELECTRIC RAILWAYS.

MORRIS, ILL.—The Joliet & Northern Electric Railway Company has been granted a franchise to enter the city.

ATLANTIC CITY, N. J.—The Central Passenger Railway Company has been incorporated with a capital of $40,000, to operate a road in the city.

LANCASTER, PA.—Work on the new trolley road between this city and Reading is progressing rapidly, and the line is expected to be in operation by August 15.

CINCINNATI, OHIO—It is stated that the Lake Erie, Bowling Green & Napoleon Electric Railroad Company has voted to increase its capital stock from $300,000 to $1,000,000.

GREENVILLE, S. C.—The city council has granted a fifty-year franchise to the Greenville & Anderson Electric Railway for fifty years. It is expected that the survey of the line will begin shortly.

JAMESTOWN, N. Y.—The Jamestown, Chautauqua & Lake Erie Railroad, which runs from Jamestown to Westfield, skirting Chautauqua Lake for its entire length, is to be converted into an electric trolley line.

ATLANTA, GA.—It is stated on good authority that Birmingham parties are arranging to build an electric railway from Eppes to Gainesville, a distance of about nine and one-half miles. Something like $95,000 will be required to construct and equip the road.

DRYDEN, N. Y.—It is reported that an electric road will be built from Ithaca to Horseheads, where it will connect with the Elmira system. The road will be thirty-four miles long, which is fourteen miles shorter than the road at present connecting these places.

LONG BRANCH, N. J.—The Long Branch commissioners have granted a forty-five-year franchise to the Monmouth County Electric Company, to construct and operate a double-track trolley in this city. The work is to be completed by 1905, and will be begun on October 15 next.

CHANUTE, KAN.—The Chanute council has granted a twenty-five-year franchise to J. P. McCamm to build an interurban electric line to cover the entire oil and gas belt. The company behind Mr. McCamm pledges to spend $1,000,000 on the enterprise, and to begin work within sixty days.

LOUISVILLE, KY.—Contracts for the construction of the interurban railway line from Louisville to Mount Washington have been let, and the construction will be begun as soon as preliminary arrangements are completed. A contract has been closed with the Louisville Railway Company for the power with which the road is to be operated, and rights of way have been secured through the country.

DAYTON, OHIO—A traffic arrangement has been closed between the Xenia & Wilmington Traction Company and the Dayton & Xenia line, by which the former company will run its cars into this city over the latter company's tracks. The Jamestown & Xenia division of the Xenia & Wilmington line will be constructed at once. This will give direct traction service between this city and Wilmington.

ELECTRIC LIGHTING.

GREENE, N. Y.—This village has voted to own its own electric light plant and to construct waterworks.

PLATTSMOUTH, NEB.—Charles C. Parmele has been granted a twenty-five-year franchise for an electric light plant.

RICHMOND, VA.—The Virginia Passenger and Power Company is installing a new 600-horse-power addition to its plant in Petersburg.

IPSWICH, MASS.—At a special town meeting, the town voted to appropriate $25,000 to establish a municipal electric lighting plant.

NILES, MICH.—Charles A. Chapin has completed work on his dam in the St. Joseph River, at Buchanan, and is now transmitting electric power to Niles and South Bend. The dam furnishes 4,000 horse-power.

WASHINGTON, N. J.—Lambertville has contracted with the electric light company to light the city with arc lights for a year at the rate of $100 per light. Incandescent lamps are to cost $35 each per year.

SALT LAKE CITY, UTAH—The Utah Light and Power Company is preparing to increase the capacity of the Jordan River plant to 1,500 horse-power over and above what was originally proposed, making the entire capacity of the plant 3,000 horse-power. It is estimated that the work will cost $100,000.

EASTON, PA.—At the annual meeting of the stockholders of the People's Electric Light and Power Company, the following board of directors was elected: Dr. E. W. Evans, S. R. Bush, M. H. Jones, Frank G. Ormsby, G. B. Garrison, John S. Osterstock and W. H. Walters. The directors elected the following officers: Dr. Evans, president; F. G. Ormsby, secretary, and John S. Osterstock, treasurer.

ALBANY, N. Y.—The Frontier Electric Lighting Company, of Buffalo, formed by interests connected with the Buffalo Gas Company, was incorporated recently to operate in Buffalo, and the towns of Tonawanda, Cheektowaga and West Seneca, Erie County. The capital is $800,000, and the directors are: Alexander C. Humphries, Frederick Strauss and Stephen Peabody, of New York city; Howard L. Clark, of Providence, R. I.; Robert L. Fryer, William S. Riselay and Frank D. Locke, of Buffalo.

INDUSTRIAL ITEMS.

ROSSITER, MACGOVERN & COMPANY moved on May 1 to new and greatly enlarged quarters in the Whitehall Building, overlooking Battery Park and New York Bay, presenting a very inviting prospect. These are ideal offices, for in hot summer days they will assuredly be "cooled by ocean breezes."

F. H. LOVELL & COMPANY has moved its headquarters to 92 William street, New York city. Extra facilities in a modern office building will allow the company to facilitate its shipments of the material of which it is making a specialty. The company is presenting to the market a particularly good line of overhead material and will be pleased to quote prices on specifications.

CROSELMIRE & ACKOR, 42 Walnut street, Newark, N. J., manufacturers of platinum specialties, announce that they have had an unusually busy year, with constantly increasing orders from the electric trade. This company manufactures all kinds of platinum wire for the electric and automobile industries, and states that it is ready to promptly fill all orders for platinum wire.

THE H. C. ROBERTS ELECTRICAL SUPPLY COMPANY has moved into larger headquarters at 905 Arch street, Philadelphia, Pa. The H. C. Roberts company is supplying the market with a fine line of specialties and can fill orders of an exceptionally varied nature at short notice. The company will be pleased to greet its patrons in new offices which will greatly facilitate a convenient interchange of business.

SCHLESINGER & MEARS have moved their headquarters to 92 William street, New York city. This company is now showing an attractive line of sockets, receptacles, cutouts, telephone instruments, incandescent lamps, porcelain insulators, cleats and special porcelain and semi-porcelain tubes. The company is representing some of the most prominent manufacturers and will be pleased to send full information on request.

THE FIBRE CONDUIT COMPANY, Orangeburgh, N. Y., manufacturer of underground conduit, is distributing to its patrons, and will be pleased to send the same to any one interested, a useful wire-table which fits the vest pocket. This company makes a fibre conduit which is easily bent and also tapped and threaded, making a special set of couplings with elbow, tee and cross joints to facilitate rapid construction. The company will be pleased to send information on application.

THE BRIDGEPORT BRASS COMPANY, New York and Bridgeport, Ct., reports large foreign orders for "Phono-Electric" wire. The Glasgow Corporation Tramways are equipping their new extension with "Phono-Electric" trolley wire. The success of this wire abroad has been very pronounced and many of the large trolley systems are using it, particularly where heavy service is required. The Walsall, England, Corporation Tramways have ordered "Phono-Electric" wire for their entire equipment.

HARVEY & HUBBELL, Bridgeport, Ct., announces that the Hubbell pull cluster system has been installed in the State, War and Navy annex, corner of Pennsylvania avenue and Seventeenth street, Washington, D. C., by the George A. Fuller Construction Company. In many instances these clusters are taking the place of chandeliers both in store and office buildings. The Hubbell clusters have many features of merit and present an economical and satisfactory method of lighting by electricity.

C. W. HUNT, West New Brighton, N. Y., will be pleased to send to any one interested a new pamphlet descriptive of coal-handling machinery. The Hunt industrial railways and apparatus for coal handling and conveying is becoming more popular with advancing installations. This company has had a long experience in the designing and manufacturing of coal-handling apparatus and will build to specifications of sufficient variety to suit any commercial conditions, producing economic results.

THE BUFFALO ELECTRIC CARRIAGE COMPANY, Buffalo, N. Y., announces the opening of permanent offices and salesrooms at 941 and 943 Eighth avenue, New York city. The company is the builder of automobiles "run by electricity." Messrs. Babcock and Linn are the managers of the New York office, and they will be pleased to receive prospective buyers and invite the inspection of all and will be able to show a fine line of touring cars, breaks, stanhopes and vehicles for city use, whether pleasure or business.

THE ELECTRIC STORAGE BATTERY COMPANY has recently contracted for the installation of five yacht lighting plants on boats now in construction at Morris Heights, New York. The use of storage batteries for lighting private yachts is rapidly increasing, so much so that the greater number of private yachts now turned out are equipped with storage batteries. The advantage of the storage battery lies in the fact that it allows the light to be used throughout the night while the machinery is shut down, avoiding the alleged annoyance of the generator vibration while running with the yacht at anchor.

THE CENTURY GLASS COMPANY, Bellaire, Ohio, is securing a number of large orders for its product throughout the country. This company has just completed a set of new buildings and a battery of six new lehrs. New machinery has been added to the equipment and the company is ready to fill orders of any magnitude promptly. This company makes both gas and electric shades, either plain or etched, inner and outer globes, arc globes, ball globes and fish globes. The company has just issued its No. 3 catalogue and No. 6 Red Book, giving some valuable information for users of glass products. This will be sent on application.

E. P. ROBERTS COMPANY, consulting engineer, Electric Building, Cleveland, Ohio, announces that owing to the increasing demands of its eastern business it has opened a branch office at 25 Broad street, New York city. This office has been placed under the management of Mr. W. C. Andrews who is the eastern representative of the company. The company is ready to take up work in any locality and its large experience in making preliminary reports, plans, specifications, investigations of existing properties, supervision of operating plants, etc., enables it to make unprejudiced and conservative estimates on the construction or reorganization of electrical and lighting plants, etc.

SWEDISH-AMERICAN TELEPHONE COMPANY, Chicago, Ill., has produced a magnificent "art souvenir" descriptive of its product. This is tastefully printed in black and pale olive, the half-tone reproductions of telephone apparatus being especially fine. The new desk telephone No. 70, manufactured by this company, is illustrated in detail showing the essential construction of this piece of apparatus. Besides this there are shown parts of the transmitter, gravity hook, lightning arresters, test sets, condensers, repeating coils and receivers, together with some handsome illustrations of combined toll and rural line switchboards, metallic switchboards, long-distance toll and monitor switchboards. The souvenir is tastefully bound in a dark green rag cover, embellished with an embossed gold ornamentation.

THE WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY, Pittsburg, Pa., has sold to the Empire State-Idaho Mining and Development Company, Spokane, Wash., three motors for driving concentrating mill machinery and a large air compressor in the Cœur d'Alene's. These motors will be supplied with power from the 2,300-volt secondary circuits of the Washington Water Power Company, of Spokane. The company is also supplying the San Francisco & San Joaquin Coal Company, of San Francisco, Cal., with machinery for operating briquetting presses. Two forty-horse-power, slow-speed, 500-volt, direct-current motors, together with the speed-controlling rheostats, designed to vary the speed of the motors from twenty revolutions per minute to 550 revolutions per minute in about fifteen steps, have also been supplied.

THE ALLIS-CHALMERS COMPANY, Chicago, Ill., reports the following partial list of engine sales for March, 1903: Tremont & Suffolk Mills, Boston, Mass., one 21 and 48 x 48, 1890, cross-compound, Reynolds-Corliss engine; Carnegie Steel Company, Pittsburg, Pa., one 42 and 66 x 60, tandem rolling mill engine; Oliver Iron Mining Company, Duluth, Minn., one 16 x 36, 1890 frame, Reynolds-Corliss engine; Leonoir Cotton Mills, Leonoir, N. C., one 28 x 42, low-pressure side; Marietta Knitting Works, Marietta, Ga., one 12 x 36, girder frame, Reynolds-Corliss engine; Milwaukee Chair Company, Milwaukee, Wis., one 20 x 42, girder frame, Reynolds-Corliss engine; South Side Elevated Railway Company, Chicago, Ill., one 34 and 70 x 54, 1890, horizontal, cross-compound, Reynolds-Corliss engine; International Traction Company of New Jersey, Jersey City, N. J., two 34 and 68 x 48, 1890, cross-compound, condensing, Reynolds-Corliss engines; Pennsylvania Railroad Company, Pennsylvania, one cross-compound, Riedler air compressor, 15 and 24 x 36.